SUGARBEET RESEARCH

1989 REPORT

FOREWARD

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SUGARBEET RESEARCH

1989 Report

Section A

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BIANCARDI, E. and R. T. LEWELLEN. Breeding for rhizomania resistance in sugarbeet. IIRB 53rd Winter Congress, Abstracts of Papers, Brussels, Feb. 14-15, 1990, p. 19. 1990.

Rhizomania has been known for 30 years. Only recently have programs been designed to breed specifically for resistance (tolerance) and to determine the genetic basis of differential host-plant reactions. Most resistance presently found in commercial hybrids has been derived from "Italian" germplasm. The resistance in traditional Alba-Rovigo types appears to be additive or quantitatively inherited and was the first to be commercially exploited. The "Rizor" type of Italian resistance appears to fit a pattern of dominance or qualitative inheritance.

In 1983 a high level of resistance was found in a monogerm line. This "Holly" resistance is conditioned by a major dominant gene assigned the symbol Rz. More recently, high resistance was found within Turkish germplasm. Resistance also appears to be due to a major dominant gene. Its relationship to Rz is unknown. Within diverse Beta maritima germplasm, resistance has been identified. At Salinas, resistance from B. maritima is being transferred to sugarbeet with promising results. The inheritance of resistance is complex and probably both qualitative and quantitative.

Most sugarbeet germplasm and parental lines are highly susceptible to rhizomania and selection has been negative. However, within lines that showed variability for reaction, selection for resistance has proven to be successful. Selection studies and realized improvement have suggested that resistance is quantitative and heritabilities reasonably high. It is not known how unique or independent these quantitatively inherited sources of resistance may be. Resistance within the USA, Italian, and B. maritima sources may be similar. It is possible to establish a common lineage among these sources starting with Munerati's program.

Both individual plant (mass) selection and family or line (progeny test) selection have been used to improve resistance. Comparisons among near-isogenic lines generated by backcrossing and mass selection demonstrate the efficacy of this method and of the Rz factor. Where resistance fits quantitative patterns, both mass and family selections have been used. Examples such as family 401 and C39R from the authors' programs clearly demonstrated their effectiveness for variety improvement. Selection methods have involved either or both visual estimates of disease severity or immunoenzymatic assays (ELISA) for BNYVV. Results from reliable experiments suggest that visual and ELISA tests are highly correlated and that both techniques

identify genotypes with differential reactions. Presently achieved levels of resistance may be sufficient to protect sugarbeet production in low to moderate disease. These levels of resistance may be insufficient under severe conditions; it may be necessary to deploy varieties that possess both higher and combined types of resistance. The development of varieties with both types of resistance will be discussed.

DONEY, D. L. and E. D. WHITNEY. Germplasm collection and preservation: insurance for the future. J. Econ. Bot. 44: (In Press). 1989.

Although agronomically undesirable and offering little commercial value, wild relatives of our present crop plants may have many desirable stress-resistant characteristics due to long exposure to nature's stresses. Early U.S. collection activities for wild forms of Beta were conducted by George H. Coons (USDA-ARS) in 1925 and 1935. These collections were mainly wild forms of the section Beta, with major emphasis on leaf spot (Cercospora beticola) resistance. Resistance in wild sugarbeet hybrids was not notably improved over the sugarbeet parents and the evaluation was discontinued. Nothing more was done with this collection until 1976, when John McFarlane (USDA-ARS) transferred it to Salinas to regenerate seed for preservation. Unfortunately, about half of the collection had lost germinability. Rhizomania, a devastating sugarbeet root disease, was discovered in California in 1983. Shortly after this discovery, E. D. Whitney began screening some of the Coon's collection for Rhizomania resistance and found immunity in several accessions. Interestingly, these same accessions subsequently have been found to exhibit Erwinia root rot resistance, sugarbeet root maggot tolerance, and moderate leaf spot resistance. Needs change and the value of wild germplasm may not be realized for years. The need to collect and preserve this valuable natural resource is illustrated by these examples of pest resistance. As future needs for other traits develop, the true value of these collections will be realized.

DONEY, D. L., E. D. WHITNEY, et al. The distribution, elimination and dispersal of Beta maritima germplasm in England, Wales, and Ireland. J. Sugar Beet Res. 27: (In Press). 1989.

Abstracted in Fargo, North Dakota Section.

DUFFUS, J. E. Virus-whitefly-plant interactions - An increasing threat to world agriculture. Proc. VI Int. Conf. Comparative Virology, W7-2. 1989.

The whitefly-transmitted viruses, known in all continents except perhaps Antarctica, produce a wide and divergent group of diseases, most of which have not been characterized. The agents are transmitted by at least three whitefly species in the

nonpersistent, semipersistent, persistent and by biological mechanisms. The viruses cause significant losses throughout the world and are responsible for some 70 important diseases in the tropical and sub-tropical areas. Recent years have shown an increase in losses in wide areas north and south of the tropics, approaching areas of intensive agricultural production. The whitefly-transmitted diseases have been characterized in general on the basis of their transmission by whiteflies and the activity of the agents on host plants, such as symptoms and host range. A compilation of available data on the viruses themselves would suggest at least seven groups of viruses differing in type of virus particle, symptom type, and vector relationships. These include geminiviruses, and viruses similar to the closteroviruses, caraviruses, potyviruses, nepoviruses, luteoviruses and a DNA-containing rod-shaped virus. Technical control measures to reduce vectors seem to be ineffective, so cultural measures to reduce disease incidence have to be developed.

GERIK, J. S. Rhizomania: Challenging problem faces California, Texas growers. The Sugar Producer 15(3):27-28. 1989.

Rhizomania has become a major disease of sugarbeet in California. The origin of the disease is Europe where it was first recognized in the mid-1950's. Today the disease occurs in most sugarbeet producing areas of the world. Rhizomania was first discovered in the United States in a field near Paso Robles, California in 1983. It has since spread throughout the sugarbeet growing areas of California's central and coastal valleys. Today, more than 70 thousand acres in California are infested with Rhizomania. Thus far in the United States the disease is known to occur only in California and Texas where it was found in 1985.

GERIK, J. S. and J. C. HUBBARD. Effect of soil water matric potential on infection by Polymyxa betae and beet necrotic yellow vein virus. Phytopathology 79:1223. 1989.

The effect of soil water matric potential on infection of sugarbeet by viruliferous Polymyxa betae was studied using a loam soil from the Salinas Valley of California which was infested with the pathogens. The soil was saturated with water and the matric potential was adjusted with a soil moisture extractor to potentials of -0.1, -0.2, -0.3, -0.4, -0.6, and -1.0 bar. Sugarbeet seedlings were transplanted into saturated soil and the adjusted soils in sealed glass beakers, and incubated for 2 weeks in a growth chamber at 24 C. The plant roots were then assayed for infection by beet necrotic yellow vein virus (BNYVV) by sandwich ELISA. Plants incubated in the -0.3 bar and wetter soils were positive for BNYVV. No plants incubated in -0.4 bar or drier soil were infected with the virus. The experiment indicates that P. betae, the vector of

BNYVV, is unable to infect sugarbeet roots in this soil when the matric potential is -0.4 bar or less.

GERIK, J. S., A. F. VAN MAREN, and J. E. DUFFUS. 1989. Association of tomato bushy stunt virus with tomato decline in the California desert. Proc. 6th Conf. ISHS Work. Group on Vegetable Viruses, p. 35. 1989.

Tomato decline (TD) has been a factor limiting the production of fresh market tomatoes in the desert areas of California since 1977. The disease is characterized by stunted plants with rolled leaves and leaflets which turn chlorotic; present on the roots are cylindrical necrotic lesions. Yield of infected fields may be reduced by as much as 80%. The disease occurs only in fields with a history of previous tomato crops. Although TD is known to be soil borne, the cause of the disease, until now, has not been determined. Tomatoes grown for three weeks in a growth chamber at 14° C in soil collected from a field with a history of TD became infected with a Tombusvirus serologically indistinguishable from the BS-3 strain of tomato bushy stunt virus (TBSV). Field grown, symptomatic plants collected during 1987 and 1988 were consistently found to be infected with TBSV, as determined by ELISA and bioassay. Eight tomato cultivars, which in field observations were considered to be very susceptible or very resistant to TD, were mechanically inoculated with TBSV and grown in the greenhouse. The symptoms were most severe on the TD susceptible plants, but were very mild on TD resistant plants. Plants grown in autoclaved soil infested with freeze dried preparations of the virus at 16° C were infected with TBSV 3 weeks after planting, indicating that a soil vector is not required for infection to occur. These experiments implicate TBSV as the etiological agent of TD.

GERIK, J. S., A. F. VAN MAREN, D. C. STENGER, and J. E. DUFFUS. Etiology of tomato decline. Phytopathology 79:1161. 1989.

Tomato decline (TD) of fresh market tomatoes in the desert areas of California has been observed since 1977. The disease occurs only in fields with a history of previous tomato crops. Although TD is known to be soil borne, the cause of the disease, until now, has not been determined. Tomatoes grown for 3 weeks in a growth chamber at 14 C in soil collected from a field with a history of TD became infected with a Tombusvirus serologically indistinguishable from the BS-3 strain of tomato bushy stunt virus (TBSV). Field grown, symptomatic plants collected during 1987 and 1988 were consistently found to be infected with TBSV, as determined by ELISA and bioassay. Eight tomato cultivars, which in field observations were considered to be very susceptible or resistant to TD, were mechanically inoculated with TBSV. The symptoms were most severe on the TD susceptible plants, but were very mild on TD resistant plants. These experiments implicate TBSV as the etiological agent of TD.

HASSAN, AHMED A. and J. E. DUFFUS. Observations and investigations on the yellowing and stunting disorder on cucurbits in the United Arab Emirates - A review. Emirates J. Agr. Sciences (In Press). 1990.

A yellowing and stunting disorder of cucurbit crops had reached epidemic proportions in U.A.E. since 1985, particularly on melon (Cucumis melo) and watermelon (Citrullus lanatus). Symptoms of the disorder are bright interveinal chlorosis on the older leaves and partial interveinal light green mottling on the intermediate leaves, while young leaves remain symptomless or show only pin-point chlorotic spotting. Hassan indicated the virological nature of the disorder, and referred to lettuce infectious yellows virus (LIYV) as the most probably causal agent. Long flexuous filamentous virus-like particles were observed in most affected samples examined by Lecoq, and were suspected to be the causal agent of the disorder. Symptoms failed to develop on melon plants covered for 35 days from seeding with a spun-ponded polyester material (Agryl P17) which prevented the tobacco whitefly (Bemisia tabaci) from feeding on the plants. Based on serological tests of over 150 samples, and field observations of known hosts of LIYV, it is concluded that the causal agent of YSD differs from LIYV in serological affinities and probably in host range. It should probably be considered a new virus of the closterovirus-like group similar to LIYV. A low level of symptom development was observed in melon cvs. Maskotaly, Magger Kings, Caribe F_1, Rocky Sweet F_1 and Midstar F_1, while a few hundreds of other cucurbit cvs. tested were found susceptible.

During the course of investigating the etiological nature of the disorder, cucumber mosaic virus, muskmelon mosaic virus, squash mosaic virus and cucumber vein yellowing virus were positively identified on various cucurbits in U.A.E. The latter virus was observed by Makkouk as the second most important one on cucurbits after the one causing the disorder.

HILLS, F. J., R. T. LEWELLEN, and I. O. SKOYEN. Sweet sorghum cultivars for alcohol production. Calif. Agric. 44:14-16. 1990.

Sweet sorghum does well in much of California. Cultivars were tested that showed a potential for producing from 475 to 575 gallons of ethanol per acre.

HOEFERT, L. L. Ultrastructural evidence of plasmodesmatal modification in plant virus infections. Am. J. Bot. Abstr. 76:67. 1989.

The normal ultrastructure of plasmodesmata appears to be altered in plant virus infections. The extent of the modification depends not only upon the progress of the infection but also upon the morphology of the particular virus present. Large spherical

viruses (50-60nm) cause extensive plasmodesmatal changes while smaller elongated virus (18 x 1000nm) or smaller spherical viruses (22-25nm) produce relatively less extensive changes in plasmodesmata of infected cells. Comparisons were made of plasmodesmatal changes in cells of several plant hosts infected with viruses that possessed diverse virion morphology.

LEWELLEN, R. T. and E. BIANCARDI. Breeding and performance of rhizomania resistant sugar beet. Proc. 53rd Winter Congress, IIRB, Brussels (In Press). 1990.

See abstract by Biancardi and Lewellen.

LIU, H-Y. and J. E. DUFFUS. Purification, particle morphology and serology of beet pseudo-yellows virus. Proc. 6th Conf. ISHS Working Group on Vegetable Viruses, p. 16. 1989.

Beet pseudo-yellows virus (BPYV), inducing one of the most important virus diseases in commercial greenhouses throughout the world, has been purified from BPYV-infected Nicotiana clevelandii Gray plants. Purified preparations have an $A_{260/280}$ nm ratio of 1,315 and contain long flexuous particles approximately 12 nm wide and 1,500 to 1,800 nm long. Virus yield ranged from 100 to 400 ug/kg of leaf tissue using an extinction coefficient of 3 $(mg/ml)^{-1}$ X cm^{-1} at A_{260} nm. An antiserum to BPYV was prepared which has enabled us to diagnose BPYV-infected plants by using indirect enzyme linked immunosorbent assay (ELISA) but not with direct ELISA tests. This greenhouse whitefly (Trialeurodes vaporariorum) transmitted virus has been diagnosed previously only by transmission and host range tests. This is the first report on the discovery of the particle morphology of BPYV and the production of an antiserum which can be used for serodiagnosis.

MARTIN, F. N. and E. D. WHITNEY. In-bed fumigation for control of rhizomania of sugar beet. Plant Dis. 74:31-35. 1990.

Preplant application of fumigants by single chisel in plant bed centers significantly increased beet and sugar yields of sugar beets 5-6 months old. Products containing dichloropropene were the most effective in controlling rhizomania. In separate studies, application of Telone II at 29.3, 43.9, and 58.6 L/ha raised sugar yields 83-182, 252, and 78-258%, respectively, compared to the control treatments. Vorlex, Vorlex 201, and Pichlor 60 also reduced disease incidence and significantly increased yield when applied at 132.7, 146.1, and 32.7 L/ha, respectively. Sealing the soil with water, although not essential for effective control, significantly increased yield over unsealed treatments with Telone II at 29.3 L/ha and all rates of Vorlex. Although metham-sodium and the low rate of chloropicrin (21.3 L/ha) did not control rhizomania, sugar yields were 42 and 44% greater, respectively, than in control

treatments, possibly because other root pathogens were controlled. Protecting plants from infection for the first 9-11 wk after planting appeared to be critical for preventing beet and sugar yield reductions caused by rhizomania.

PERRING, T. M., G. S. NUESSLY, J. E. DUFFUS, and N. C. TOSCANO. Epidemiology of whitefly-vectored lettuce infectious yellows virus in southern California. Proc. IV Int. Plt. Virus Epidem. Workshop, 1989, pp. 268-271. 1989.

Fall lettuce growers in the Imperial Valley of southern California have experienced severe yield losses due to disease caused by lettuce infectious yellows virus (LIYV), which is vectored by the sweetpotato whitefly, Bemisia tabaci (Gennadius). Several studies have determined the importance of cotton and melons in the development of LIYV epidemics. The present study was undertaken to evaluate further the interacting effects of cotton and cucurbits in the development of LIYV epidemics in lettuce. Our objectives were to describe the temporal and spacial distribution of B. tabaci on cotton, melons and lettuce, and define the interaction among seasonal whitefly densities and LIYV infections in melons and lettuce.

Whitefly numbers virtually were undetectable until early July in both years of the study. At this time whitefly densities began to increase in cotton, peaking near the end of September. When melons were planted, whiteflies moved into them from the cotton, and increased at approximately the same rate as those in cotton. Whitefly numbers in melons also peaked near the end of September. It should be restated that melons not only provide excellent hosts for the whitefly, but also serve as reservoirs for LIYV. Thus the whiteflies feeding in melons have a high likelihood of being viruliferous. When lettuce emerged in early October whitefly populations in cotton and melons were declining, primarily because cotton was being dessicated and defoliated and melons were nearing harvest. This caused immigration of whiteflies from cotton and melons throughout the Imperial Valley and lettuce seedlings experience high B. tabaci populations as they emerged. Our data indicate that this is how the devastating epidemics that have characterized the Valley in recent history occurs.

Disease surveys in melons and lettuce, coupled with information on whitefly distributions add to our knowledge of the LIYV epidemic. Surveys in melons in 1987 indicated that 57% of the fields were in the low virus category. The other 43% were moderately or highly infected. In 1988, nearly 71% of the fields were in the low category, while only 30% were in the moderate or high category. Thus our survey indicated that there was more inoculum source in melons available in 1987, which should have resulted in wider distribution of the virus in

lettuce in 1987. Our lettuce surveys indicated that this was the case. In 1987, there were 26% of the lettuce fields in the low category while 74% were moderately or heavily infected. This compared to 39% of the fields in the low category in 1988, an indication that there was less virus, on a valley-wide basis in the second year. This also agreed with the whitefly information obtained for the two years in alfalfa in which there were fewer numbers of whiteflies in the valley in 1988, the year in which virus disease incidence was less.

These data help explain the interacting role played by whiteflies, which can be estimated adequately using our trapping system in alfalfa, and virus disease incidence estimated in melons, which leads to the LIYV epidemic in lettuce. Our future research will focus on this interaction in an attempt to provide information on the importance of melons in the epidemiological cycle which leads to crop loss in lettuce.

PINTO, R. L., L. L. HOEFERT, and G. L. FAIL. Plasmalemma deposits in tissues infected with lettuce infectious yellows virus. J. Ultrastruc. and Molecular Struct. Res. 100:245-254. 1988.

Lettuce Infectious Yellows Virus (LIYV) is a phloem-associated virus that is whitefly-transmitted. The physical characteristics and cytopathology of this virus are similar to other members of the Closterovirus group. One unique ultrastructural effect of the infection is the formation of conical deposits on the plasmalemmae of phloem parenchyma cells. The electron-dense deposits are osmiophilic stacks of membrane lamellae spaced at 7 nm. Flexuous virions extend between these deposits from the cytoplasm through plasmodesmata and into adjacent sieve elements. We hypothesize that these plasmalemma deposits may facilitate movement of LIYV into other phloem parenchyma cells for further replication or into sieve elements for rapid transport throughout the host.

STENGER, D. C. and J. E. DUFFUS. Genomic characterization of beet curly top virus isolates. Phytopathology 79:1158. 1989.

Full-length, infectious DNA clones have been constructed for three distinct isolates of beet curly top virus (BCTV). Progeny virus derived from cloned genomes of the Logan (severe on Beta vulgaris, wide host range), Worland (mild on B. vulgaris, wide host range), and Horseradish (narrow host range) isolates were transmitted by Circulifer tenellus, and displayed the same phenotypes as the original isolates. A fourth BCTV genome (severe, wide host range) was inadvertently cloned as a contaminant of the Horseradish isolate. Southern hybridization assays indicated that each cloned genome shared sequence relatedness with a full-length, infectious BCTV DNA clone previously characterized by Stanley et al. Endonuclease

restriction maps developed for the cloned BCTV genomes were distinct from one another. Infectivity assays determined that plasmids containing tandem repeats of BCTV genomes were generally more infectious than excised linear BCTV DNA inserts.

STENGER, D. C., J. E. DUFFUS, and B. VILLALON. Characterization of a geminivirus of pepper. Phytopathology 79:1214. 1989.

A geminivirus causing leaf curl and distortion symptoms was isolated from pepper (Capsicum annuum) grown in Texas. The Texas pepper geminivirus (TPGV) was transmitted persistently by Bemisia tabaci, and mechanically, to species of the Solanaceae. Electron microscopy of purified virions revealed typical geminate particles. Extracts from infected plants contained a supercoiled replicative form (RF) DNA species of 2.6 kilobase pairs. RF DNA was digested with EcoR I or Hind III and cloned into pUC8. Analysis of recombinant plasmids indicated that two distinct species were cloned from RF DNA. One TPGV DNA hybridized with DNA A of tomato golden mosaic virus (TGMV). No hybridization was observed between TPGV DNAs and TGMV DNA B. Both cloned TPGV DNAs were required for systemic infection of plants. TPGV is a typical whitefly transmitted, bipartite geminivirus not previously known to occur in the United States.

YU, M. H. Assessment of resistance to root-knot nematode in sugarbeet. J. Sugar Beet Res. 26:A29. 1989.

Root-knot nematodes, Meloidogyne spp. can be a serious problem to sugarbeet production. These nematodes are parasitic to more than 90 host crops in addition to sugarbeet. The three Patellares species, i.e., B. patellaris, B. procumbens, and B. webbiana, that have high resistance to Heterodera schachtii were susceptible to Meloidogyne spp. Therefore, it was important to investigate the possible existence of tolerance or resistance to this nematode complex within sugarbeet germplasm. A wide variety of sugarbeet genotypes that were derived from domestic and foreign sources were used in this study. Assessment was conducted in the laboratory and greenhouse. Early infection by larvae of this nematode species was characterized by the formation of small galls or exudation of egg matrices on the root system of sugarbeet seedlings. However, gall formation does not necessarily indicate susceptibility of a plant. The preliminary observations from this study showed that approximately 94% of the inoculated seedlings had detectable galls on their root system. At the present, classification of susceptibility or resistance of a plant is pending on the fate of gall size, gall number, and nematode reproductivity during the subsequent growth of the plant.

YU, M. H. Reactions and derivatives from beet leaf tissue culture. J. Sugar Beet Res. 26:A30. 1989.

Plant tissue culture has become an important tool in exploration of the biological characterization of plants. Leaf explants from selected beet genotypes of various germplasm sources were cultured on modified Murashige and Skoog media plus N6-benzyladenine and 1-Naphthaleneacetic acid. Callus formation was most prolific on leaf samples excised from accessions of Beta vulgaris and B. maritima of section Vulgares. However, little or no callus was induced from explants of B. patula of Vulgares, and B. patellaris and B. procumbens of Patellares. Although roots and root-like structures occasionally appeared on calli that formed on the auxin-free medium, none of those roots developed into useful root systems in the established regenerants. The upper threshold temperature for beet in vitro regeneration was about 33° C. At this temperature and above, explants from accessions of more than 75% of Beta species examined did not survive or survived but did not differentiate. It seems that in the genus of Beta, the further the species were morphologically from B. vulgaris, the less was their ability to regenerate under investigated conditions. Somaclonal variation in sugarbeet regenerants involved leaf morphology and chromosome complements.

YU, M. H. Genetic analysis of the dwarf curly leaf tomato mutant via hybridization with Curl and dwarf mutants. Genome 32:359-364. 1989.

The characteristics of the dwarf curly leaf tomato (Lycopersicon esculentum Mill.) mutant, cu-3, were investigated via hybridization with the Curl, Cu, and dwarf, d^{cr}, mutants. When Cu plants were crossed to cu-3 or d^{cr} parents, F_1 plants expressed the Cu phenotype, whereas two parental and two nonparental types were present in each F_2. The transgressive groups were the wild type (+), which developed normal expanded leaves, and the midvein-invisible type (MI), which developed extremely distorted curly leaves. Crosses between cu-3 and d^{cr} plants produced nonparental wild-type plants in F_1, and two parental and one wild type in F_2. There was no allelism or linkage between cu-3 and Cu, d^{cr}, or dpy (the dumpy) mutant). Cu was epistatic to both cu-3 and d^{cr}. The cu-3 allele was epistatic to d^{cr}; however, d^{cr} plants (in the cu-3+ cu-3 d^{cr} genotype) could produce cu-3 progeny. The cu-3 plants always bred true. With the involvement of cu-3, a decrease in fruit size and seed yield was not due to a reduction in leaf size or leaf numbers per inflorescence but was due to genic interaction. The cu-3 hindered the Cu-type progeny from becoming a majority group in Cu and cu-3 hybridizations. It caused a >33% decrease in fruit size and >50% decrease in seed number per fruit of Cu, d^{cr}, +, and MI progeny of its Cu and d^{cr} hybrids.

YU, M. H. An induced leaf morphological variation on sugarbeet. Agron. Abstr. p. 180. 1989.

Most sugarbeet regenerants from leaf callus culture retained the characteristics of the donors, yet a small portion exhibited somaclonal variations. Research was undertaken to evaluate one of the morphological changes, leaf intumescence, which displayed frothy appearance on blade surfaces. Leaf intumescence occurred in several regenerants derived from sugarbeet trisomics. This trait was transmittable to F_1 and later progenies, and was closely associated with the extra chromosome in the genome. The irregular surface of the leaf was due to the formation of enations. Enations were created by hyperplastic growth of mesophyll and epidermis. Veins were apparently underdeveloped and many stomata malformed.

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COHEN, S., J. E. DUFFUS, R. PERRY, and R. DAWSON. A collection and marking system suitable for epidemiological studies on whitefly-borne viruses. Plant Disease 73:765-768. 1989.

FALK, B. W., L. S. CHIN, and J. E. DUFFUS. Complementary DNA cloning and hybridization analysis of beet western yellows luteovirus RNAs. J. Gen. Virol. 70:1301-1309. 1989.

JOHNSTONE, G. R., J. E. DUFFUS, and P. L. GUY. New records on the occurrence of beet western yellows virus in Australia, New Zealand and Mexico. Australian J. Agric. Res. 40:353-358. 1989.

LEWELLEN, R. T. Registration of cytoplasmic male-sterile sugarbeet germplasm C600CMS. Crop Sci. 29:246. 1989.

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LEWELLEN, R. T. and I. O. SKOYEN. Screening sugarbeet genotypes for nonbolting tendency using an annual tester. J. Sugar Beet Res. 26:A15. 1989.

LEWELLEN, R. T. and I. O. Skoyen. S_1 progeny recurrent selection to improve yield of sugarbeet. J. Sugar Beet Res. 26:A14. 1989.

SKOYEN, I. O., R. T. LEWELLEN, and E. D. WHITNEY. Comparison of resistance to rhizomania from diverse sources. J. Sugar Beet Res. 26:A22. 1989.

TEMPLE, S. R., M. KIRK, and R. LEWELLEN. Field inoculation and screening of sugarbeet varieties and experimental lines for resistance to beet yellows virus. J. Sugar Beet Res. 26:A25. 1989.

WHITNEY, E. D. Beta maritima as a source of powdery mildew resistance in sugar beet. Plant Dis. 73:487-489. 1989.

WHITNEY, E. D. Identification, distribution and testing for resistance to rhizomania in Beta maritima. Plant Dis. 73:287-290. 1989.

WHITNEY, E. D. and B. E. MACKEY. Differences in aggressiveness of Erwinia carotovora subsp. beta vaculoroum strains and their reaction to sugarbeet cultivars. Plant Dis. 73:220-222. 1989.

EVALUATION OF SUGARBEET GERMPLASMS FOR RESISTANCE TO ROOT-KNOT NEMATODES

M. H. Yu

Up to the present, sugarbeet genotypes with resistance to root-knot nematode have not been available. In order to search for the resistance to this pest, sugarbeet germplasm from different sources are being screened. Root-knot nematode resistance seems to be rare within the accessible sugarbeet materials. All sugarbeet lines, which were assembled from different sources including the United States and many foreign countries, examined thus far have shown root knot formation on the root systems of the inoculated plants. Growth pouches have been utilized for this screening. After galls which developed on the roots of the inoculated plants were classified on a scale of 1 to 5, the great majority of sugarbeet lines were rated 5; where 1 represents 0% and 5 represents 75 to 100% of plants having galls. When cone-tainers were utilized for the seedling tests, a considerable higher number of galls and eggs per plant were observed.

There was a wide range of variations on the number of galls formed and eggs reproduced from roots of the greenhouse grown sugarbeets. The size and shape of these galls also varied noticeably. A portion of the results from such screening are listed in Table 1. The number of root knots per single plant observed ranged from 12 of line S1056 to over 500 of line P1127, and that of the egg reproduction ranged from 1,000 of line S1056 to 177,750 of line 14492. There have been no parallel correlations between the number of galls formed and the amount of eggs and larvae recovered. Line S1056 exhibited the lowest number in both galls and eggs under the investigated conditions. Assuming the strength of inoculum was adequate and screening procedures were proper, these results suggest the existence of genetic variability among the sugarbeet lines investigated. If the traits for low gall and egg production are inheritable, nematode tolerant sugarbeet lines can be developed. A resistant or tolerant sugarbeet should give better control of nematodes than chemicals. In a sugarbeet production field while the resistant plants stifle nematode reproduction throughout the crop season, the fumigation effects wear off and allows the nematode population to rebuild.

The above observations were obtained after some 100 accessions of germplasm lines that were acquired from more than ten countries were screened. The inheritability of the lower gall formation and egg reproduction traits is yet to be determined. In a comparable situation, resistance to cyst nematode was never identified from sugarbeet cultivars. Breeding sugarbeet resistant to cyst nematode is, therefore, emphasized on the transgression of resistant germplasm from wild beet species elsewhere in the genus, by many researchers. However, interspecific hybridization has always been time

consuming and labor intensified. It should be considered only after extensive screening efforts have failed to achieve the goal. For this reason, priority must be given to the identification of transmittable root-knot nematode resistance from the wide array of available beet germplasms.

Table 1. Observations on sugarbeet root-knot nematode (Meloidogyne incognita race 1) reproduction under greenhouse conditions*

Source cultivar	Days after inoculation	No. galls observed	No. eggs reproduced
13535	76	200	48,000
		175	80,650
		25	9,000
14492	71	200	56,250
		150	177,750
		100	51,750
P1004**	70	50	11,250
		35	10,500
		70	13,500
P1107	74	30	12,750
		150	72,000
		145	28,500
P1108	69	100	25,500
		100	18,000
		75	44,250
P1127	70	50	8,400
		75	8,400
		500	52,500
S1056	97	35	8,250
		65	4,600
		12	1,000
S1057	91	60	24,000
		32	1,150
		33	4,240
USH10	69	100	25,500
		95	18,000
		75	44,250

*Numbers of galls and eggs were estimated.
**Cone-tainers were used.

The Effect of Fumigation on Resistant Cultivars for Rhizomania Control 1989 (Con't. from 1988 Sugarbeet Research, pg. A29).

E.D. Whitney, I.O. Skoyen, R.T. Lewellen

Results of four sugarbeet cultivars tested under nonfumigated and fumigated conditions with Telone II at 8.5 gal per acre in 1989.

	Gross Sugar, lbs/a		Root Yield, t/a		% Sucrose		Beets/100 ft row		% Soluble Solids	
Varieties	Fum	Non-fum	Fum	Non-fum	Fum	Non-fum	Fum	Non-fum	Fum	Non-fum
R39 (C3)	9299	6016	28.7	18.8	16.2	16.0	133	147	19.2	19.1
Rizor-3	8586	6610	26.5	20.4	16.2	16.2	149	150	19.6	19.5
Rhizosen	8550	5606	28.5	19.6	15.0	14.3	148	139	17.7	17.5
U.S. 11	5016	1725	19.0	7.7	13.2	11.2	115	110	15.7	14.6

	% Non-Sucrose Soluble Solids		Raw Juice Apparent Purity		% Clean Beets		Disease Index	
Varieties	Fum	Non-fum	Fum	Non-fum	Fum	Non-fum	Fum	Non-fum
R39 (C3)	3.0	3.1	84.3	83.6	91.8	90.1	0.10	0.79
Rizor-3	3.4	3.3	82.6	82.8	90.3	89.0	0.25	1.12
Rhizosen	2.7	2.7	85.0	84.4	92.5	87.3	0.32	1.41
U.S. 11	2.6	3.2	77.0	78.1	89.0	80.5	0.73	3.46

Project Title: Development of monoclonal antibodies specific for P. betae.
Project Number: 140
Project Leader: James S. Gerik
Other Personnel Involved: Lynn Wunderlich, James E. Duffus

Research Progress: Hybridomas have been constructed from mouse spleen tissue. In preliminary experiments, using a system much simpler than P. betae, we have successfully produced monoclonal antibodies to a plant virus. Cysts of P. betae have been isolated from sugarbeet roots and injected into mice. Soluble protein extracts from P. betae infected roots have been injected into mice. Attempts to produce stable hybridomas producing antibodies to P. betae have, so far, been unsatisfactory; but, preliminary results indicate some antibody activity to P. betae. These negative results have been mainly due to a lack of an adequate screening procedure. Improved screening procedures, such as immuno-dot, western blots, and the use of centrifugation to attach cysts of P. betae to ELISA plates, are being developed for the P. betae system. Attempts to characterize cellular proteins from roots infected with P. betae have begun in the effort to isolate a infection specific protein to P. betae. The use of single dimensional gel electrophoresis to characterize these proteins appears inadequate due to the large number of proteins present. Experiments using 2-dimensional gel electrophoresis to characterize these protein have begun.

Project Title: Etiology & ecology of root rots of sugarbeet
Project Number: 220
Project Leader: James S. Gerik
Other Personnel Involved: Judy Hubbard

Research Progress: Over 130 isolates of Fusarium spp. have been collected from diseased sugarbeets over the past three seasons. These isolates are being tested for pathogenicity in green house tests. Isolates which appear to be pathogenic are being used to produce nitrate non-utilizing mutants, which can be used as tester strains. These mutants will be used in vegetative compatibility tests to identify specific pathogenic populations. Of all the isolates tested so far, nine have been pathogenic. These nine isolates include two species. When tested against each other the isolates do not pair, indicating that they belong to different populations. Isolates of Rhizopus arrhizus have been collected from diseased beets. Cultures of beet army worm have been established. Tests are under way to determine the association that these two organisms have with root rot, and the environmental conditions which are conducive for disease development. Analyses of samples of Rhizomania infected beets collected in fall harvest areas in Fresno County indicate that secondary rot is due mainly to Pythium aphanadermatum. In the summer harvest area of Kern County, Rhizomania associated rot seems to be mainly due to Phytophthora drechsleri.

Project Title: Distribution of beet necrotic yellow vein virus and *Polymyxa betae*.
Project Number: 210
Project Leader: James S. Gerik
Other Personnel Involved: Judy Hubbard

Research Progress: Over 300 soil cores, 3 feet deep, were collected in a systematic pattern in many fields in the San Joaquin Valley, to determine the spatial and vertical distributions of *P. betae* and BNYVV. Preliminary analysis indicates that *Polymyxa betae* extends at least 3 feet down in the soil profile. If *Polymyxa betae* is present in the lower profile it is also present in the upper profile as well. The reverse situation is not always true. If BNYVV is also present, the frequency of *Polymyxa betae* occurrence is greater in the upper profile than the lower profile. Samples were also collected from fields which contain clustered areas where infestations are absent. These samples are being analyzed chemically, physically and microbiologically to determine what factors are different in these soils.

DEVELOPMENT OF BREEDING LINES AND GERMPLASM

R. T. Lewellen and I. O. Skoyen

PERFORMANCE OF NEMATODE RESISTANT LINE B883 - In 1987 a small quantity of seed of B883 was obtained from IRS, Bergen op Zoom, the Netherlands. This line was released as being homozygous resistant to cyst nematode. Resistance was derived from Beta procumbens (Heijbroek, W. et al. 1988. Sugarbeets homozygous for resistance to beet cyst nematode (Heterodera schachtii Schm.) developed from monosomic additions of Beta procumbens to B. vulgaris. Euphytica 38:121-131). The seed of this line was increased and coded N801 and hybrids with CMS females were produced and coded N801H#. A brief description of our results and experiences with this line are given.

As stated in the release, B883 (N801) is fully self-fertile as are its hybrids. It segregates for red and green hypocotyl color but otherwise appears to be highly homozygous, uniform, and of low vigor. As a paradox, in a winter bolting test, it is very easy bolting (but not an annual) but seed stalks, flowers, and pollen develop very slowly to the point of being much later than normal sugarbeet lines. Pollen production is low. Because of low vigor, B883 (N801) is difficult to evaluate for reaction to diseases, but it appears to be highly susceptible to powdery mildew, virus yellows, rhizomania, etc. that occur in California. It is uniformly resistant to cyst nematodes in both greenhouse and field plot evaluations at Salinas.

Its F_1 hybrids are also highly and uniformly resistant to cyst nematodes, but advanced generations have a lower than expected frequency of resistance assuming resistance is inherited as a single dominant gene. Fertile F_1 hybrids appear to be normal for bolting and pollen production. However, in a set of 60 F_3 lines randomly derived from F_2 plants, the three F_3 lines that appeared to be homozygous resistant came from F_2 plants with low pollen fertility and low seed yield. Nematode resistance may then still be linked with partial pollen sterility as was the case with Savitsky's and McFarlane's nematode resistant lines with a similar B. procumbens background.

In F_1 hybrids, plant vigor is restored and most yields are nearly normal. However, in all cases, the F_1 hybrids were 2-4 percentage points lower for sucrose than corresponding F_1 hybrids. The results of tests with F_1 hybrids evaluated in 1989 trials at Brawley and Salinas and presented in many of the following tables.

BYV INFECTED HS PROGENY TEST OF Y54 - Half-sib families from multigerm, self-sterile line Y54 were produced in 1988 and evaluated in 1989. A selection from Y54 was released in 1988 as C54. Y54 was advanced from a series of composite crosses by mass selection for resistance to virus yellows (BYV/BWYV), powdery mildew, and Erwinia root rot and sugar yield. Y54 is composed of germplasm from C17/C37, C64, and C01/C31 in approximately the proportion of 58:20:22%. Because of its overall adaption to California and tolerance to virus yellows, it was chosen as a source for BYV resistance selection. The 100 half-sib families were tested at Salinas in a test to evaluate yield under BYV infected conditions and a test to evaluate disease reaction to Erwinia and powdery mildew. The most resistant families will be selected, increased and tested for GCA and disease resistance as components of experimental hybrids. Results of the progeny test are summarized in Test 1589.

TEST 1589. Means and ranges for HS families from Y54 at Salinas.

100 entries x 3 reps., RCB
1-row plots, 16 ft. long

Planted: February 21, 1989
Harvd: November 8, 1989
Inoc.BYV: May 12, 1989

Variable	Mean	Range	LSD (.05)	CV(%)
Sugar Yield/A	8,197	5,345 - 11,359	2,213	16.8
Root Yield/A	28.8	22.8 - 35.1	5.2	11.3
% Sucrose	14.2	11.2 - 16.3	2.1	9.2
RJAP (%)	81.8	77.0 - 86.4	5.1	3.9
VY Score	4.2	3.4 - 4.7	0.6	8.8
PM Score	2.3	0.3 - 4.7	2.0	53.2
% Bolters	0.02	0.0 - 2.0	NS	1732
Beets/100ft	123	98 - 144	26	12.9
Test ER3089				
Erwinia DI	1.4	0.0 - 10.0	--	--
Mean PM	2.3	0.3 - 4.0	--	--

Test 3089 inoculated with Erwinia. Means for C40 and USH11 checks were 48.2 and 1.9 for ERR and 6.0 and 5.5 for PM.

S_1 PROGENY RECURRENT SELECTION AND EVALUATION - Monogerm, self-fertile, population-790 has been used to evaluate S_1 progeny recurrent selection to improve sugarbeet populations. Four cycles of selection have been completed to produce the popn-790C4 synthetic (see tests 589 & 2289 in this report and tests 688 & 2588 in the 1988 report). S_1 progeny recurrent selection improved popn-790 per se for most traits, but appears to have had very little influence on changing or improving the population for hybrid performance or GCA.

The four cycles of S_1 progeny evaluations were generally made in late (April) plantings at Salinas. Over the years, when comparisons have been made between the source synthetic (C0) and the various advanced cycles, the greatest measured response to selection has always been obtained when the synthetics were also planted in late season trials. There has always been a much reduced response when comparisons were planted early (January) or away from Salinas. In the two trials in 1989 (Test 589 planted in January and 2289 planted in late February) the greatest response or gain in the synthetics was for the February planted trial. Not only does S_1 progeny recurrent selection under these conditions appear to be specific to Salinas but also quite specific to the shorter season or later planting dates. These observations suggest that the S_1 progeny evaluation trials should be at more than one location, year, or season. However, these data do show that to a specific testing site and time, S_1 progeny recurrent selection can be very useful to improve a population.

S_1 progenies from popn-790C4 were produced in 1988 and tested in 1989. For the fifth cycle of selection, S_1 progeny evaluation trials were grown at Brawley and Salinas and emphasis was placed on disease resistance, 100 S_1 progenies were evaluated. At Brawley (see test B389 in Brawley section of this report) severe infection with lettuce infectious yellows virus (LIYV) occurred. At Salinas, test 489 was planted in November to evaluate for bolting and test 1489 was inoculated with beet yellows virus (BYV). The results of these tests are presented below.

A wide dispersion occurred for most variables within these S_1 progeny tests suggesting significant genetic variability. This variability was probably largely for reaction to disease. From these 100 S_1 families, 16-20 will be selected and randomly mated to produce the C5 synthetic. A few apparently superior lines will be selected and increased and then evaluated as components of experimental hybrids. The criterion of selection will be an index based upon gross sugar yield within or over tests (disease resistance), sucrose concentration, purity, and resistance to bolting and powdery mildew. Particular attention will be given to lines that performed near the top of all three tests, but test 1489 under BYV infected conditions is considered the most critical.

TEST 489. Means and ranges for S_1 progeny families from popn-790C4 at Salinas

100 entries x 3 reps., RCB
1-row plots, 16 ft. long

Planted: November 28, 1988
Harvd: November 14, 1989

Variable	Mean	Range	LSD (.05)	CV (%)
Sugar Yield/A	8,010	4,900 - 11,970	3,220	24.9
Root Yield/A	32.5	24.4 - 40.9	7.9	15.1
% Sucrose	12.2	8.5 - 14.9	2.8	14.5
RJAP (%)	79.4	67.0 - 85.3	7.9	6.2
% Bolters (7/6)	2.5	0.0 - 28.7	5.9	147
% Bolters (9/8)	6.3	0.0 - 42.8	8.7	86.2
PM Score	2.2	0.3 - 5.1	1.3	36.2
% Rot	0.5	0.0 - 5.3	2.6	358
Beets/100 ft	162	114 - 197	30	11.3

Primary purpose of test was to evaluate for bolting tendency.
Test was moderately infected with cyst nematode.

TEST 1489. Means and ranges for S_1 progeny families from popn-790C4 at Salinas

100 entries x 3 reps., RCB
1-row plots, 16 ft. long

Planted: February 21, 1989
Harvd: November 13, 1989
Inoc.BYV: May 12, 1989

Variable	Mean	Range	LSD (.05)	CV (%)
Sugar Yield/A	6,430	4,284 - 8,927	1,830	17.6
Root Yield/A	25.5	19.1 - 34.6	5.1	12.5
% Sucrose	12.6	9.2 - 15.6	2.0	9.7
RJAP (%)	79.1	71.6 - 86.0	5.6	4.4
VY Score	5.0	3.5 - 6.0	0.7	8.9
PM Score	3.9	0.3 - 6.7	1.9	30.0
% Bolters	0.3	0.0 - 1.6	0.6	1218
% Rot	0.7	0.0 - 2.2	1.0	880
Beets/100 ft.	131	102 - 154	21.5	10.2

FIELD VARIETY TRIALS, SALINAS, CALIFORNIA, 1989

Location: USDA-ARS Agricultural Research Station

Soil Type: Sandy loam (Chualar series)

Previous Crops: 1989 Sugarbeet test areas, Spence Field: Block 5, 18 Acres; fallow 1986, sugarbeets 1985, oat hay 1987, 88.

Fertilizer Used: Preplant: 450 lbs/A 8:20:10 broadcast and chiselled in prior to listing. Before seeding, about 330 lbs/A ammonium sulfate was Bye-Hoe incorporated in a 9-inch band into the beds.

Supplemental nitrogen: One to three applications, as sidedress ammonium sulfate or by sprinkler system as 32% nitrogen in a liquid formulation.

Total fertilization (lbs/A);	N	P_2O_5	K_2O
Block 3	308	90	45

Summary: 1988-89 Tests at Salinas (Spence Field):

Test No.	Sowing Date 1988-89	Thinning Date 1989	Test Entries No.	Reps No.	Plot Row No.	Plot Lgth. Ft.	Harvest Date 1989	Test Design
189	11/28	2/13-14	80	3	1	16	----	1
289	11/28	2/14-15	160	3	1	16	----	1
389	11/29	2/15-16	160	3	1	16	----	1
489	11/28	2/16-17	100	3	1	16		TL[2]
589	1/18	3/6	16	8	1	30	9/27	SB
689	1/18	3/6	32	8	1	30	10/3-4	RCB
789	1/19	3/7	32	8	1	30	9/25-26	RCB
889	1/18	3/7	32	8	1	30	9/20-21	RCB
989	1/18	3/8	32	8	1	30	10/4-6	RCB
1089	1/17	3/8	32	8	1	30	10/10-11	RCB
1189	1/17	3/9	32	8	1	30	9/28-29	RCB
1289	1/17	3/9-10	32	8	1	30	10/11-12	RCB
1389	1/18	3/10	8	8	1	30	10/6	SB
1489	2/21	3/28	100	3	1	16		TL[2]
1589	2/21	3/29	100	3	1	16		TL[2]
1689	2/21	3/31	16	8	1	30	10/19-20	SB
1789	2/22	4/3	8	8	1	30	10/20	SB
1889	2/22	3/31	32	8	1	30	11/6-7	RCB
2089	2/22	3/28	32	8	1	30	10/18-19	SB
2189	2/22	3/29	16	8	1	30		SB
2289	2/22	3/29	16	8	1	30	10/2-3	SB
2389	2/22	3/30	32	8	1	30	10/16-17	RCB
2489	2/23	3/30	32	8	1	30	10/12-13	RCB
2589	5/2	6/12	150	2	1	8	----	3

Summary: 1988-89 Tests at Salinas (Spence Field): (continued)

Test No.	Sowing Date 1988-89	Thinning Date 1989	Test Entries No.	Reps No.	Plot Row No.	Plot Lgth. Ft.	Harvest Date 1989	Test Design
2689	5/2	6/12	100	2	1	8	----	[3]
2789	5/1	6/9	96	5	1	16	----	[4]
2889	5/1	6/9	8	1	16	65	----	[5]
2989	5/1	6/9	32	1	1	20	----	[6]
2989	5/1	6/9	176	2	1	20	----	[6]
3089	5/1	6/7	120	1	1	20	----	[7]
3189	5/1	6/6	120	2	1	20	----	[8]

Summary: 1989 Rhizomania Tests (Research Station Field):

Test No.	Sowing Date 1988-89	Thinning Date 1989	Test Entries No.	Reps No.	Plot Row No.	Plot Lgth. Ft.	Har.-Sel Date 1989	Test Design
RZM 189-1	5/15	6/14	64	3	1	10	10/13	RCB[9]
RZM 189-2	5/17	6/14	24	4	1	16	11/1	RCB[10]
RZM 189-3A	5/17	6/14-15	112	1	1	16	10/12	[11]
RZM 189-3B	5/17	6/14-15	117	1	1	16	10/26	[11]
RZM 189-3C	5/17	6/14	48	1	1	16	10/13	[11]
RZM 189-4	5/17	6/15	24	10	1	16	10/30-31	RCB
RZM 289-1	8/2	8/28-29	16	8	1	16	11/29	RCB
RZM 289-2	8/2	8/28-29	16	8	1	16	11/29	RCB
RZM/NR 289-3	8/2	8/28-29	16	4	1	16	11/30	RCB
RZM/NR 289-4	8/2	8/28-29	24	-	1	7	12/13	[12]
RZM/NR 289-5	8/2	8/28-29	36	-	1	7	12/11-12	[12]
RZM 389-1	8/1	8/29	28	6	1	13	11/20	RCB
RZM 389-2	8/1	8/29	32	6	1	13	11/21	RCB
RZM 389-3	8/1	8/29	16	6	1	13	11/30	RCB
RZM 389-4	8/1	8/30	12	6	1	13	11/30	RCB[13]
RZM 389-5	8/1	8/30	8	6	1	13	11/30	RCB
RZM 389-6	8/1	8/30	18	-	1	7	12/6	[14]
RZM 389-8	8/1	8/31	20	-	1	200	12/5-8	[15]

[1] Bolting resistance observation trials.
[2] 10x10 triple lattice designs (analyzed as RCB).
[3] Indexing test crosses and annuals for bolting tendency.
[4] Coded Powdery Mildew evaluation of test and market hybrids.
[5] BYV-ERR-PM mother root selection.
[6] ERR-PM evaluation and observation of lines.
[7] ERR-PM Eval., Sel., and Obs. Test of Half-Sibs.
[8] ERR-PM Eval. of Hybrids
[9] Eval. Ames PI-#'s for BWYV and rhizomania
[10] RZM. Eval. of C_0,C_1,C_2,C_4 Synthetics of Y39 and Y47.
[11] RZM Obs. and Sel. w/in BSDF nursery
[12] Combined Nema-RHZ resistance Sel.
[13] RZM eval. of lines w/Res. fr. B.maritma.
[14] RZM inheritance of resistance and allelism fr. P.I.206407
[15] Sel. for resistance to RZM.

Irrigation: By either furrow or sprinkler system as required at 7-14 day intervals except during stand establishment when frequent light sprinkler irrigations were used.

Herbicide use: Norton EC at an average rate of 3 qts/A and 2.5 qts/A Pyramin FL, were sprayed post plant and sprinkled in with 1/2 to 3/4 inch water.

Disease and insects: Natural virus yellow infection (BWYV) was light during 1989 season. Black bean aphid infestation was moderate in 1989. Test filed sprayed once with Meta Systox R and once with Lannote for aphid control.

Powdery mildew was light in 1989 when not controlled and appeared first (late June) in the earliest seeded tests. Good control was obtained with a single spray application of Bayleton at 8-10 oz. ai/A.

Natural infection of Erwinia soft rot was light in susceptible lines in 1989. Impact on yield was slight. Counts of rotted roots were made at harvest. Roots with rot were eliminated from the sugar samples.

Sugarbeet nematode was observed only in 1989 bolting tests.

Rhizomania was not observed in 1989 Spence field tests. Severe in rhizomania tests.

Remarks: 1989 test area had Telone II at 18 gal./A chiseled in broadcast, in October 1989 for nematode and rhizomania control.

TEST 1389. COMMERCIAL HYBRIDS UNDER NORMAL AND HIGH NITROGEN FERTILITY, SALINAS, CA., 1989

8 entries x 8 reps x 2 trmts, split-block[1]
1-row plots, 30 ft. long

Planted: January 18, 1989
Harvested: October 6, 1989

Variety	Description	Acre Yields Sugar Lbs	Acre Yields Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	RJAP %
HH 37	Holly	15,601	46.58	16.74	0.3	0.0	131	84.67
6625	Betaseed	15,574	42.03	18.54	0.6	1.2	135	85.66
Rhizosen	Holly	15,299	45.43	16.87	3.4	0.1	128	85.41
4757	Betaseed	15,282	47.34	16.14	0.3	0.1	135	84.15
SS-NB3	Spreckels	14,794	44.85	16.50	0.0	0.0	127	84.97
USC-5	Union	14,109	42.57	16.52	0.1	0.0	138	84.15
US H11	786442	13,453	44.02	15.26	0.6	0.0	130	83.51
SS-Z1	Spreckels	12,881	40.62	15.84	0.0	0.2	112	82.64
MEAN for normal N		15,036	43.76	17.19	0.7	0.3	133	85.33
MEAN for high N		14,213	44.60	15.92	0.6	0.1	127	83.47
LSD (.05) for varieties		1,024	2.62	0.60	1.2	0.5	7.6	1.48
C.V. (%)		7.00	5.40	4.70	229.4	299.2	6.7	2.20
F value varieties		8.2**	6.3**	20.9**	7.0**	5.5**	8.7**	3.7**
F value Nitrogen		13.8**	3.6NS	40.0**	0.7NS	4.1NS	5.9*	50.7**
F value V x N		1.2NS	1.1NS	0.6NS	0.3NS	2.1NS	0.7NS	0.8NS

[1]This test was grown near the Area 4 Coded Variety Trial to determine the effects of nitrogen fertility on the relative performance of commercial hybrids under test at the USDA's Spence Field site. Two rates of nitrogen were used, normal for our testing procedure and higher than normal. There was no evidence that at these levels nitrogen fertility caused significant interactions or changes in the various variables for varieties.

TEST 689. GCA OF CMS LINES WITH C46, SALINAS, CA., 1989

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 18, 1989
Harvested: October 3-4, 1989

Variety	Description[1]	Acre Yield		Sucrose	Bolters	Root Rot	Beets/ 100'	RJAP
		Sugar Lbs	Beets Tons	%	%	%	No.	%
6625	Betaseed	16,437	40.23	20.46	0.0	0.6	119	83.2
4757	Betaseed	16,312	43.41	18.83	0.3	0.6	127	82.8
Y846H20	87-309H3 x Y746	15,923	42.62	18.65	0.0	0.0	123	83.6
KW 1745	Betaseed	15,872	38.84	20.48	0.2	1.2	128	82.9
HH41	Holly L41330	15,834	44.39	17.90	0.5	0.0	134	81.4
Y846H21	87-309H72 x Y746	15,712	42.92	18.29	0.3	0.0	112	82.8
Y846H61	7766-8HO x Y746	15,698	44.65	17.64	0.3	0.0	126	82.7
Y846H13	5546H92 x Y746	15,589	42.53	18.33	0.0	0.0	117	82.5
Y846H39	C762-17HO x Y746	15,573	43.47	17.94	0.0	0.7	114	83.2
Y846H3	F82-562HO x Y746	15,534	41.46	18.77	0.0	0.4	118	83.0
Y846H72	83-718HO x Y746	15,514	44.40	17.48	0.0	0.0	119	82.6
Y846H38	C312HO x Y746	15,461	43.03	17.98	0.7	0.0	116	82.8
Y846H63	7766-38HO x Y746	15,458	43.12	17.92	0.0	0.0	113	83.8
Rhizosen	L 49302	15,453	41.58	18.63	4.0	0.0	119	83.0
SS-NB3	Spreckels	15,408	41.26	18.67	0.0	0.4	123	83.5
Y846H99	6796-6HO x Y746	15,369	41.56	18.52	0.0	0.0	114	83.1
Y846H92	85-796-22CMS x Y746	15,351	41.51	18.51	0.0	0.0	110	81.4
US H11	(786442)C546H3 x C36	15,292	42.84	17.88	0.6	0.0	121	82.9
Y846H66	C766-23HO x Y746	15,275	42.25	18.06	0.0	0.0	116	81.5
Y846H70	C766-62HO x Y746	15,269	42.41	18.02	0.3	0.3	107	83.5

TEST 689. GCA OF CMS LINES WITH C46, SALINAS, CA., 1989

(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	RJAP %
Y846H85	C790-92HO x Y746	15,140	42.73	17.77	0.0	0.0	118	84.2
Y846H89	C790-68HO x Y746	15,047	40.04	18.83	0.0	1.1	114	83.1
Y846H23	87-309H37 x Y746	14,926	42.13	17.69	0.3	0.0	127	81.6
Y846H24	87-309H92 x Y746	14,894	41.00	18.15	0.0	0.3	106	81.6
Y846H26	87-309CMS x Y746	14,844	40.84	18.23	0.0	0.4	104	82.3
Y846H97	C796-43HO x Y746	14,689	41.04	17.94	0.0	0.3	116	82.9
Y846H64	7766-44HO x Y746	14,629	41.59	17.60	0.0	0.0	131	83.6
Y846H84	C790-69HO x Y746	14,521	40.03	18.14	0.0	0.0	108	82.3
Y846H8	82-546H3 x Y746	14,246	39.59	18.01	0.0	0.3	125	83.3
Y846H37	85-306CMS x Y746	14,064	42.20	16.69	0.0	0.0	112	82.9
Y846H94	6796-28HO x Y746	13,968	38.81	18.00	0.0	0.0	98	81.6
Y846H62	7766-14HO x Y746	13,693	40.24	17.04	0.0	0.4	103	82.0
MEAN		15,219	41.83	18.22	0.2	0.2	117.3	82.7
LSD (.05)		1,332.84	3.32	0.72	0.9	0.8	10.8	NS
C.V. (%)		8.9	8.1	3.4	361.1	332.8	9.3	2.20
F value		1.8**	1.6*	8.8**	5.2**	1.5*	4.8**	1.4NS

[1] F_1 hybrid codes for CMS's are: HO = CMS line, H3 = C562, H37 = C306, H72 = C718, H92 = C796-22. Y746 = reaction of C46/2.

TEST 789. HYBRID PERFORMANCE OF ADVANCED LINES AND POPULATIONS, SALINAS, CA., 1989

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 19, 1989
Harvested: September 25-26, 1989

Variety	Description[1]	Acre Yield		Sucrose	Bolters	Root Rot	Beets/ 100'	RJAP
		Sugar Lbs	Beets Tons	%	%	%	No.	%
Y731H70	C766-62HO x C31/6	16,362	44.64	18.32	0.3	0.0	117	84.4
6625	Betaseed	16,165	40.20	20.12	0.0	2.6	120	83.6
HH 37	Holly 37368	15,923	42.76	18.67	0.6	0.0	121	83.5
Y846H114	7224aa x Y746	15,825	43.26	18.30	1.7	0.0	123	83.4
Y731H8	82-546H3 x C31/6	15,651	42.23	18.54	0.0	0.0	113	83.7
Y854H26	87-309CMS x Y654	15,521	41.78	18.57	0.0	0.3	122	83.0
Y846H55	5767-47aa x Y746	15,506	43.50	17.84	0.0	0.0	122	82.6
Y846H67	7767aa x Y746	15,489	41.68	18.59	0.3	0.0	119	83.6
Y846H39	C762-17HO x Y746	15,448	43.42	17.76	0.3	0.0	114	83.1
SS-NB3	Spreckels	15,447	42.58	18.20	0.0	0.3	115	83.2
Y854H66	C766-23HO x Y654	15,363	42.98	17.86	0.4	0.0	119	82.5
Y731H42	C742-24HO x C31/6	15,348	40.51	18.97	0.7	1.2	118	82.9
US H11	786442	15,348	43.50	17.64	0.3	0.0	123	83.5
Y731H66	C766-23HO x C31/6	15,345	42.44	18.09	0.3	0.4	107	83.8
Y846H36	C790Laa x Y746	15,322	42.28	18.17	0.3	0.0	117	83.2
Y846H54	5767-46aa x Y746	15,275	40.30	18.94	0.4	0.0	107	83.2
Y846H82	C310 x Y746	15,274	40.65	18.81	0.0	0.3	121	83.1
Y846H50	5767-20aa x Y746	15,192	40.52	18.77	0.0	0.0	116	83.2
Y846H76	7776aa x Y746	15,189	41.72	18.18	0.6	0.0	120	82.3
Y846H8	C546H3 x Y746	15,097	41.97	17.98	0.0	0.0	118	83.3

TEST 789. HYBRID PERFORMANCE OF ADVANCED LINES AND POPULATIONS, SALINAS, CA., 1989

(continued)

Variety	Description[1]	Acre Yield Sugar lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	RJAP %
Y846H51	5767-27aa x Y746	15,007	41.12	18.23	0.3	0.3	118	83.6
Y846H72	83-718HO x Y746	14,996	43.08	17.39	0.0	0.0	116	82.7
Y854H89	C790-68HO x Y654	14,976	41.11	18.22	0.3	2.7	126	83.4
Y854H8	82-546H3 x Y654	14,964	41.08	18.22	0.3	0.7	111	83.1
Y846H38	C312HO x Y746	14,864	42.21	17.58	0.0	0.3	119	83.4
Y846H26	87-309CMS x Y746	14,813	40.43	18.31	0.3	0.0	108	83.1
Y854H70	C766-62HO x Y654	14,700	41.42	17.77	0.0	0.3	109	82.9
Y846H53	5767-44aa x Y746	14,691	40.74	18.04	0.3	0.0	118	84.2
Y846H66	C766-23HO x Y746	14,666	41.51	17.62	0.3	0.0	117	83.0
Y846H52	5767-30aa x Y746	14,384	41.28	17.40	0.4	0.0	89	82.5
Y846H70	C766-62HO x Y746	14,171	40.46	17.49	0.0	0.4	105	82.4
Y846H96	C796aa x Y746	13,416	37.96	17.67	0.3	0.0	119	82.0
MEAN		15,179	41.73	18.20	0.3	0.32	116	83.2
LSD (.05)		1207.1	3.0	0.55	NS	1.2	10.0	NS
C.V.(%)		8.1	7.2	3.1	308.3	379.9	8.7	1.2
F value		1.7*	1.6*	8.2**	1.1NS	2.5**	3.9**	1.5NS

[1]Y854 = early version of C54. Y746 = reselected C46/2. aa = genetic ms. HO = CMS. 7224, 7767, 7776, C790, C796, C310 = mm, SF(self-fertile), A:aa populations.

TEST 889. PERFORMANCE OF POPULATION HYBRIDS, SALINAS, CA., 1989

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 18, 1989
Harvested: September 20-21, 1989

Variety	Description[1]	Acre Yield		Sucrose	Bolters	Root Rot	Beets/ 100'	RJAP
		Sugar Lbs	Beets Tons	%	%	%	No.	%
8909H114	7224aa x 7909	17,657	46.49	19.00	0.9	0.0	127	86.4
6625	Betaseed	17,082	41.04	20.79	0.0	1.8	136	85.2
Rhizosen	L49302	16,752	44.37	18.89	2.0	0.0	118	85.5
Y846H105	7855aa x Y746	16,603	44.03	18.88	0.3	0.0	114	86.0
R839H77	7776HO x R739(C3)	16,304	43.46	18.83	1.0	0.0	119	84.1
Y854H68	7767HO x Y654	16,298	44.03	18.49	0.0	0.0	128	84.7
Y854H83	6756HO x Y654	16,292	42.92	18.96	0.3	0.0	122	85.8
R839H114	7224aa x R739(C3)	16,137	42.76	18.88	4.4	0.8	111	85.1
Y846H114	7224aa x Y746	16,044	43.23	18.56	0.5	0.0	123	86.7
Y846H68	7767HO x Y746	15,977	43.89	18.23	0.7	0.0	118	85.8
Y846H77	7776HO x Y746	15,952	42.51	18.77	0.0	0.0	114	85.0
R873H68	7767HO x R773	15,907	43.70	18.29	3.4	0.0	120	84.2
7906H68	6767HO x 6235,6,7	15,871	44.31	17.89	3.1	0.0	120	84.8
Y839H83	6756HO x R739(C3)	15,797	42.99	18.35	1.3	0.0	121	84.3
Y854H20	87-309H3 x Y654	15,749	42.75	18.40	0.6	0.0	121	83.1
Y873H83	6756HO x R773	15,736	43.79	17.96	3.0	0.0	126	84.4
Y731H20	86-309H3 x C31/6	15,686	42.15	18.63	1.5	0.0	118	85.8
Y854H77	7776HO x Y654	15,650	42.90	18.23	0.0	0.0	124	85.3
8909H68	7767HO x 7909	15,593	43.19	18.06	0.9	0.0	129	83.4
Y846H102	7852aa x Y746	15,583	43.03	18.09	2.0	0.0	116	84.4

TEST 889. PERFORMANCE OF POPULATION HYBRIDS, SALINAS, CA., 1989

(continued)

Variety	Description[1]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Root Rot	Beets/ 100'	RJAP
		Lbs	Tons	%	%	%	No.	%
R839H20	87-309H3 x R739(C3)	15,549	41.65	18.69	1.0	0.0	119	84.5
R873H114	7224aa x R773	15,519	41.99	18.50	1.6	0.0	105	85.6
Y731H77	5776HO x C31/6	15,431	42.07	18.33	0.3	0.0	124	84.1
R839H68	7767HO x R739(C3)	15,245	41.72	18.30	3.2	0.0	113	83.6
US H11	786442	15,157	41.72	18.20	0.9	0.3	131	85.1
R847H68	7767HO x R747	15,084	41.71	18.08	4.3	0.0	123	85.9
R873H77	7776HO x R773	15,066	40.89	18.50	3.5	0.0	117	85.2
Y846H83	6756HO x Y746	15,016	40.21	18.69	0.3	0.0	118	84.1
SS-Z2	Spreckels	14,909	38.97	19.15	0.0	0.0	122	85.5
Y846H20	87-309H3 x Y746	14,895	40.05	18.60	0.0	0.0	120	84.7
R873H20	87-309H3 x R773	14,728	39.60	18.61	0.6	0.0	123	84.1
N801H20	87-309H3 x B883	14,110	43.11	16.36	1.6	0.3	130	85.0
MEAN		15,730	42.54	18.50	1.3	0.1	121	84.9
LSD (.05)		1,243.8	3.15	0.69	2.2	0.47	10.36	NS
C.V. (%)		8.0	7.5	3.8	159.4	453.9	8.7	2.5
F value		2.6**	1.9**	7.0**	3.0**	4.5**	2.79**	1.3NS

[1]B883 = cyst nematode resistant line from the Netherlands. R773 = near iso-line of C46/2 with R_Z. R747 & R739C3 are early versions of C47R & C39R. 7906 & 7909 = MM, SF, A:aa, R_Z populations. 7224, 7852, & 7855 = mm, SF, A:aa, R_Z populations. 6756(C310/6), 7767, & 7776 = mm, SF, A:aa populations. aa = genetic ms; HO = CMS.

TEST 989. EVALUATION OF EXPERIMENTAL HYBRIDS WITH RHIZOMANIA RESISTANCE, SALINAS, CA., 1989

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 18, 1989
Harvested: October 4-6, 1989

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	RJAP %
R839H114	7224aa x R739(C3)	17,258	48.44	17.88	5.8	0.0	114	83.4
R873H114	7224aa x R773	17,177	49.64	17.31	1.4	0.0	112	82.3
R847H68	7767HO x R747	17,108	51.25	16.70	3.0	0.0	127	82.9
Y846H101	7851aa x Y746	17,071	48.93	17.49	0.6	0.0	115	82.9
8909H114	7224aa x 7909	17,069	50.45	17.00	1.2	0.0	129	84.0
R873H68	7767HO x R773	17,065	51.79	16.50	2.9	0.3	119	82.4
Rhizosen	49302, Holly	17,015	48.96	17.39	3.1	0.3	121	84.0
Y854H113	7860HO x Y654	16,880	50.14	16.85	0.3	1.1	110	83.2
7906H68	6767HO x 6235,6,7	16,780	50.21	16.71	3.1	0.3	115	82.9
Y846H104	7854aa x Y746	16,705	48.56	17.23	0.0	0.0	111	82.7
Y846H109	R702HO X Y746	16,702	47.78	17.48	0.3	0.0	105	83.3
Y846H8	F82-546H3 x Y746	16,658	49.10	16.99	0.0	0.0	128	84.0
R839H68	7767HO x R739(C3)	16,635	47.06	17.74	3.5	0.3	110	82.6
Y854H68	7767HO x Y654	16,443	48.47	16.96	0.3	0.0	124	83.4
Y846H114	7224aa x Y746	16,428	47.93	17.13	1.8	0.0	113	84.4
Y854H112	7852HO x Y654	16,373	46.72	17.58	1.1	0.0	117	84.4
Y846H67	7767aa x Y746	16,330	49.27	16.56	0.0	0.0	109	83.0
Y846H116	7228aa x Y746	16,329	47.41	17.17	0.6	0.0	124	82.9
Y854H111	7851HO x Y654	16,315	49.06	16.66	1.9	0.0	95	83.4
Y846H108	7862aa x Y746	16,202	47.69	17.00	1.0	0.0	116	83.1

TEST 989. EVALUATION OF EXPERIMENTAL HYBRIDS WITH RHIZOMANIA RESISTANCE, SALINAS, CA., 1989

(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	RJAP %
8909H68	7767HO x 7909	16,163	48.17	16.75	0.7	0.0	114	83.2
Y846H105	7855aa x Y746	16,139	46.69	17.29	0.0	0.0	111	81.9
Y846H117	7230aa x Y746	16,081	46.38	17.36	0.0	0.0	117	82.6
Y846H115	7226aa x Y746	16,074	47.27	17.01	1.1	0.0	112	82.4
Y846H103	7853aa x Y746	16,061	46.25	17.36	0.0	0.3	116	82.6
Y846H102	7852aa x Y746	15936	47.69	16.74	0.9	0.0	123	82.3
RIZOR-3	SES	15,838	45.49	17.42	3.3	0.3	123	82.3
Y846H100	7850aa x Y746	15,524	47.89	16.23	1.7	0.4	104	83.4
Y846H107	7861aa x Y746	15,449	45.31	17.10	0.0	0.0	115	82.9
US H11	786442	15,417	46.72	16.51	0.0	0.0	131	83.0
R839(C4)	RZM R739(C3)	15,259	44.29	17.23	3.8	0.7	116	83.0
Y846H106	7860aa x Y746	15,099	47.34	15.99	1.8	0.0	98	83.7
MEAN		16,362	48.07	17.04	1.4	0.1	115	83.1
LSD (.05)		NS	3.5	0.8	2.1	NS	10.8	NS
C.V. (%)		8.7	7.5	4.6	146.9	480.6	9.5	1.9
F value		1.4NS	1.8**	2.4**	3.8**	1.3NS	4.6**	1.2NS

[1]7224(= 7857), 7226(= 7863), 7228(= 7856), 7230(= 7858), 7850-7862 = mm, SF, A:aa, R_Z populations. 7909 & 7906 = MM, SF, A:aa, R_Z populations. R739C3 & R747 are early versions of C39R and C47R. R773 = near iso-line of C46/2 with R_Z.

TEST 1089. GCA OF MULTIGERM GERMPLASM, SALINAS, CA., 1989

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 17, 1989
Harvested: October 10-11, 1989

Variety	Description[1]	Acre Yield		Sucrose	Bolters	Root Rot	Beets/ 100'	RJAP
		Sugar Lbs	Beets Tons	%	%	%	No.	%
7906H8	F82-546H3 x 6235,6,7	15,550	47.67	16.34	2.4	0.0	125	82.6
HH37	Holly 37368	15,503	49.07	15.80	0.0	0.0	129	82.5
7906H26	86-309CMS x 6235,6,7	15,430	46.45	16.64	1.2	0.0	135	82.2
6625	Betaseed	15,149	42.69	17.67	0.0	1.6	132	82.3
R839H8	F82-546H3 x R739(C3)	15,045	47.06	16.02	3.0	0.3	123	82.8
8909H8	F82-546H3 x 7909	15,037	47.33	15.88	0.6	0.0	125	82.0
R847H68	7767HO x R747	14,789	46.42	15.99	2.7	0.0	124	83.1
R839-6H26	87-309CMS x R739-6	14,772	46.08	16.01	0.0	0.0	129	81.4
8909H68	7767HO x 7909	14,773	46.92	15.73	1.3	0.3	122	82.9
Y854H26	87-309CMS x Y654	14,632	45.78	15.91	0.3	0.0	126	80.4
SS-NB3	Spreckels	14,547	44.20	16.48	0.3	0.0	133	82.0
Y731H26	86-309CMS x C31/6	14,503	44.16	16.39	0.6	0.0	131	82.5
R873H68	7767HO x R773	14,408	47.33	15.21	1.7	0.0	122	81.7
R839H26	87-309CMS x R739(C3)	14,396	44.20	16.29	0.3	0.0	125	81.2
Y854H8	F82-546H3 x Y654	14,306	46.08	15.48	0.3	0.0	129	82.4
Y731H8	F82-546H3 x C31/6	14,294	45.18	15.84	0.0	0.0	119	82.6
R873H26	87-309CMS x R773	14,280	44.03	16.23	2.2	0.0	130	81.0
R873H8	F82-546H3 x R773	14,255	45.38	15.69	1.5	0.0	126	83.6
R839-6H68	7767HO x R739-6	14,221	46.58	15.27	0.0	0.7	123	82.6
7903H8	F82-546H3 x 6903	14,161	44.60	15.88	0.0	0.0	134	82.2

TEST 1089. GCA OF MULTIGERM GERMPLASM, SALINAS, CA., 1989

(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	RJAP %
Y846H8	F82-546H3 x Y746	14,148	45.81	15.44	0.0	0.0	126	82.4
8909H26	87-309CMS x 7909	14,140	42.96	16.48	0.0	0.0	129	82.0
Y846H68	7767HO x Y746	14,092	45.69	15.35	0.0	0.0	110	82.8
R839H68	7767HO x R739(C3)	14,063	45.30	15.52	3.8	0.0	121	82.5
R839-6H8	F82-546H3 x R739-6	14,016	44.27	15.81	0.3	0.3	129	82.5
Y854H68	7767HO x Y654	13,989	45.76	15.32	0.3	0.0	120	82.2
Y846H26	87-309CMS x Y746	13,886	42.87	16.21	0.0	0.0	101	82.4
R847H8	F82-546H3 x R747	13,772	44.50	15.45	1.0	0.0	129	82.5
R847H26	87-309CMS x R747	13,463	42.31	15.88	1.9	0.0	131	83.8
7903H26	86-309CMS x 6903	13,352	42.08	15.86	0.0	0.0	132	82.4
US H11	786442	13,246	44.27	14.90	1.5	0.0	129	82.7
N801H26	87-309CMS x B883	11,424	45.44	12.56	1.5	0.3	131	77.7
MEAN		14,300	45.27	15.80	0.9	0.1	126	82.2
LSD (.05)		1,356.5	3.0	0.90	1.6	0.6	9.5	2.3
C.V. (%)		9.6	6.8	5.9	174.2	525.8	7.6	2.9
F value		2.6**	2.3**	5.8**	3.5**	2.3**	3.9**	1.6*

[1]6235,6,7 = 7906. 7903, 7906 & 7909 = MM, SF, A:aa populations. R747, R739C3 & R739-6 are similar to C47R, C39R & C39R-6. B883 = nematode resistant line from the Netherlands.

TEST 1289. GCA OF MONOGERM LINES WITH C46, SALINAS, CA., 1989

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: January 17, 1989
Harvested: October 11-12, 1989

Variety	Description[1]	Acre Yield		Sucrose	Bolters	Root Rot	Beets/ 100'	RJAP
		Sugar Lbs	Beets Tons	%	%	%	No.	%
4757	Betaseed	15,906	47.06	16.95	0.5	0.0	138	85.3
6625	Betaseed	15,898	42.66	18.80	0.6	0.3	140	86.0
HH41	Holly L41330	15,868	45.78	17.33	2.2	0.0	133	85.7
Y846H39	C762-17HO x Y746	14,899	45.78	16.25	0.3	0.0	123	85.1
Y846H70	C766-62HO x Y746	14,879	43.25	17.26	0.0	0.0	118	85.1
Y846H8	F82-546H3 x Y746	14,609	44.40	16.46	0.0	0.0	137	84.7
Y846H52	5767-30aa x Y746	14,607	44.28	16.51	0.3	0.0	102	84.1
Y846H20	87-309H3 x Y746	14,536	41.88	17.36	0.3	0.0	135	85.1
Y846H55	5767-47aa x Y746	14,451	42.41	17.05	0.0	0.0	124	84.3
Y846H66	C766-23HO x Y746	14,414	43.94	16.58	0.0	0.0	124	84.8
Y846H61	7766-8HO x Y746	14,406	43.50	16.48	0.0	0.0	129	84.5
Y846H64	7766-44HO x Y746	14,387	43.29	16.69	0.0	0.0	124	87.2
Y846H54	5767-46aa x Y746	14,368	41.17	17.48	1.2	0.0	108	84.4
Y846H63	7766-38HO x Y746	14,281	42.39	16.85	0.0	0.3	126	84.6
Y846H50	5767-20aa x Y746	14,224	42.16	16.89	0.0	0.0	119	84.6
US-H11	786442,C546H3 x C36	14,163	44.02	16.08	0.3	0.0	136	85.7
Y846H97	C796-43HO x Y746	14,121	42.35	16.64	0.6	0.0	126	85.2
Rhizosen	L49302, Holly	14,007	40.74	17.20	4.1	0.0	134	85.3
Y846H53	5767-44aa x Y746	13,967	42.67	16.41	0.0	0.0	124	84.9
Y846H51	5767-27aa x Y746	13,947	41.40	16.86	0.0	0.0	120	84.2

TEST 1289. GCA OF MONOGERM LINES FROM C46, SALINAS, CA., 1989

(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot No.	Beets 100' %	RJAP %
46H38	C312HO x Y746	13,927	44.05	15.77	0.0	0.0	130	82.6
Y846H84	C790-69HO x Y746	13,774	39.98	17.25	0.0	0.0	119	84.6
Y846H89	C790-68HO x Y746	13,772	40.68	16.95	0.0	0.0	121	85.6
SS-Z1	Spreckels	13,628	41.04	16.66	0.3	0.7	118	84.2
Y846H72	83-718HO x Y746	13,625	44.19	15.39	0.3	0.0	124	86.4
Y846H23	87-309H37 x Y746	13,620	42.02	16.24	0.0	0.0	127	86.1
Y846H26	87-309CMS x Y746	13,497	40.65	16.63	0.3	0.0	111	84.4
Y846H85	C790-92HO x Y746	13,433	42.05	15.96	0.4	0.0	122	85.1
Y846H99	6796-6HO x Y746	13,337	39.97	16.74	0.0	0.0	120	84.1
Y846H92	F85-796-22CMS x Y746	13,296	41.16	16.16	0.0	0.0	123	84.9
Y846H94	6796-28HO x Y746	13,248	40.20	16.64	0.3	0.0	115	84.3
Y846H62	7766-14HO x Y746	13,244	42.63	15.56	0.3	0.0	110	84.4
MEAN		14,198	42.62	16.69	0.4	0.04	124	84.9
LSD (.05)		1,205	2.6	1.1	1.1	0.3	9.4	NS
C. V. (%)		8.6	6.2	6.5	281.9	780.7	7.7	2.7
F value		2.8**	3.6**	2.8**	4.2**	1.6*	7.1**	1.1NS

[1]aa = genetic ms. HO = CMS. H3 = C562HO. H37 = C306. Y746 = reselected C46/2.

TEST 2389. RETEST OF GCA OF SELECTED PROGENIES, SALINAS, CA., 1989

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 22, 1989
Harvested: October 16-17, 1989

Variety	Description[1]	Acre Yield		Sucrose	Beets/ 100'	RJAP	Powdery Mildew[2]
		Sugar Lbs	Beets Tons	%	No.	%	9/20
7767H101-11	6235-21aa x 6767	16,261	46.99	17.3	116	84.57	3.50
7767H101-7	6235-14aa x 6767	16,153	45.85	17.6	112	83.78	2.88
Y846H54	5767-46aa x Y746	15,589	43.96	17.7	129	84.01	2.75
7906H68	6767HO x 6235,6,7	15,582	47.19	16.4	125	85.03	4.38
7767H103-29	6237-13aa x 6767	15,459	45.17	17.1	132	84.34	3.63
Y846H50	5767-20aa x Y746	15,443	44.66	17.2	131	84.47	2.88
Y854H89	C790-68HO x Y654	15,410	44.97	17.0	134	85.65	2.13
7767H102-18	6236-2aa x 6767	15,394	45.34	16.9	130	84.65	2.88
Y854H70	C766-62HO x Y654	15,364	45.61	16.7	129	84.07	4.13
Y846H26	87-309CMS x Y746	15,332	44.49	17.2	136	84.44	3.50
Y846H66	6766-23HO x Y654	15,176	45.75	16.5	130	84.56	4.13
HH 41	41330, Holly	15113	44.84	16.8	139	85.64	3.88
Y846H51	5767-27aa x Y746	14,960	44.99	16.6	128	83.99	3.25
7767H103-32	6237-16aa x 6767	14,947	42.69	17.4	128	83.96	2.50
Y846H39	C762-17HO x Y746	14,911	45.91	16.1	134	84.81	2.88
Y846H97	C796-43HO x Y746	14,904	44.21	16.8	133	84.91	3.50
7767H103-30	6237-14aa x 6767	14,826	42.94	17.2	124	84.24	3.63
7767H102-23	6236-7aa x 6767	14,818	42.92	17.2	121	83.14	3.50
Y846H89	C790-68HO x Y746	14,800	42.88	17.2	131	85.97	2.13
Y846H72	83-718HO x Y746	14,776	45.22	16.3	134	86.14	2.63

TEST 2389. RETEST OF GCA OF SELECTED PROGENIES, SALINAS, CA., 1989

(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Powdery Mildew[2] 9/20
Y846H84	C790-69HO x Y746	14,751	43.01	17.1	131	83.94	1.75
Y846H53	5767-44aa x Y746	14,734	43.11	17.0	124	85.66	2.38
Y846H38	C312HO x Y746	14,609	45.17	16.0	132	83.82	2.25
Y846H92	F85-796-22CMS x Y746	14,527	42.90	16.9	125	84.71	2.63
Y846H52	5767-30aa x Y746	14,425	44.14	16.3	110	84.83	2.50
Y846H66	C766-23HO x Y746	14,385	43.56	16.4	134	84.95	3.13
Y846H85	C790-92HO x Y746	14,360	43.84	16.3	135	85.26	2.50
Y846H70	C766-62HO x Y746	14,089	43.56	16.1	134	85.06	3.63
Y846H61	7766-8HO x Y746	14,025	43.37	16.0	139	85.79	3.50
Y846H3	F82-562HO x Y746	13,658	40.98	16.6	136	84.46	3.50
Y846H62	7766-14HO x Y746	13,086	41.88	15.4	125	84.42	3.50
US H11	786442,C546H3 x C36	12,956	40.01	16.2	139	84.70	5.00
MEAN		14,838	44.13	16.7	129	84.69	3.15
LSD (.05)		1,289	3.22	0.6	10.4	NS	1.0
C.V. (%)		8.8	7.41	3.7	8.2	2.1	33.8
F value		2.6**	1.9**	5.8**	3.7**	1.3NS	3.8**

[1] mm popn-767 was used as tester for progenies 6235,6,&7 from MM,S^f popn-706. Hybrid 7906H68 = 6767HO x 6235,6,7 is the mm x MM reciprocal check. Y746 = C46/3. Y654 = early version of C54. 5767-46, -20, -27, -44, -8 from popn-767.

[2] PM was controlled through most of season with Bayleton. Late development was rated.

Note: 6235-21,-14,... were originally tested in 1988 and were selected for increase and reevaluation. See test 788, B188, 288, 3088, RZM 188-7, and RZM 388-1 for performance and reactions to bolting and diseases.

TEST 2489. RETEST OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1989

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 23, 1989
Harvested: October 12-13, 1989

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Powdery Mildew[2] 9/20
Y731H67	6767aa x F86-31/6	15,537	45.96	16.94	131	81.4	3.1
B6625	Betaseed	15,504	41.22	18.80	134	85.0	3.7
8909H68	7767HO x 7909	15,394	46.06	16.71	135	82.7	3.8
4757	Betaseed	15,246	45.31	16.74	140	81.5	2.5
Y854H26	87-309CMS x Y654	15,003	43.94	17.04	137	82.2	4.6
7906H67	6767aa x 6235,6,7	14,882	45.00	16.50	136	83.4	4.7
HH 41	Holly (41330)	14,865	45.36	16.36	132	83.1	3.7
Y846H101	7851aa x Y746	14,742	43.28	17.02	119	81.7	4.0
Rhizosen	Holly (L49302)	14,741	43.36	16.99	122	84.2	4.5
Y731H26	86-309CMS x F86-31/6	14,677	42.68	17.15	137	82.6	4.6
Y846H67	7767aa x Y746	14,574	43.70	16.63	138	81.4	2.5
Y846H82	C310aa x Y746	14,565	41.99	17.33	140	83.1	2.5
R839H68	7767HO x R739(C3)(C39R)	14,552	44.63	16.25	137	81.6	2.2
Y854H68	7767HO x Y654	14,504	44.96	16.10	124	82.2	2.6
8909H26	87-309CMS x 7909	14,452	42.85	16.85	133	81.7	5.2
Y846H115	7226aa x Y746	14,376	42.37	16.90	138	82.5	3.1
Y846H114	7224,5aa x Y746	14,300	42.48	16.71	135	82.5	3.1
R873H68	7767HO x R773($C46R_2$)	14,257	44.57	15.99	129	83.0	2.7
Y846H20	87-309H3 x Y746	14,169	42.53	16.60	130	83.3	4.6
R847H68	7767HO x R747(C47R)	14,137	43.01	16.40	137	83.0	3.5

TEST 2489. RETEST OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1989

(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Powdery Mildew[2] 9/20
Y846H26	87-309CMS x Y746	14,128	41.68	16.92	129	83.7	4.5
Y846H76	7776aa x Y746	14,109	42.09	16.69	134	83.2	2.6
Y846H36	C790Laa x Y746	14,083	42.56	16.41	133	83.4	3.3
Y846H105	7855aa x Y746	14,008	42.07	16.58	120	82.4	3.6
Y846H116	7228aa x Y746	13,897	40.18	17.27	140	83.4	2.0
R839-6H68	7767HO x R739-6(C39R-6)	13,888	42.42	16.35	136	81.8	0.3
SSNB3	Spreckels	13,567	42.00	16.19	124	81.2	4.5
Y846H23	87-309H37 x Y746	13,422	41.58	16.14	138	81.5	2.6
US H11	786442	13,342	41.55	15.99	134	82.0	5.6
R847H26	87-309CMS x R747(C47R)	13,337	39.92	16.70	139	81.9	5.7
N801H(B)	CMS-blend x B883	12,815	46.22	13.91	148	80.2	8.1
Y846H96	C796aa x Y746	12,338	37.60	16.30	128	83.3	3.0
MEAN		14,294	42.97	16.61	133	82.5	3.6
LSD (.05)		1,205	2.76	0.8	9.6	2.0	0.9
C.V. (%)		8.6	6.53	4.9	7.3	2.4	25.7
F value		2.9**	3.8**	6.3**	3.5**	2.0**	17.8**

[1] 7909, 6235-7(= 906) = MM,S^f,A:aa popns. 6767,7767, 7776, 7851, 7855, 7224, 7226, & 7228 = mm,S^f,A:aa popns.

[2] PM was controlled through most of season with Bayleton. Late development was rated.

TEST 589. PERFORMANCE AND GCA OF CO:C1:C2:C3:C4 SYNTHETICS OF POPN-790, SALINAS, CA., 1989

8 entries x 2 treatments x 8 reps, SB
1-row plots, 30 ft. long

Planted: January 18, 1989
Harvested: September 27, 1989

Variety	Description[1]	Cycle[2]	Acre Yield: Sugar Actual Lbs	Sugar Change %	Beets Actual Tons	Beets Change %	Sucrose Actual %	Sucrose Change %
Synthetics (Populations)								
8790L	7790Laa X A	C4, Syn 2	14,992	12.2	43.27	10.1	17.33	2.3
6790K	4790Kaa x A	C3, Syn 2	15,249	14.4	44.56	13.4	17.13	1.0
7790F	1790Daa x A	C2, Syn 2	14,054	5.4	40.98	4.3	17.15	1.2
7790D	7790Daa x A	C1, Syn 2	14,503	8.8	42.94	9.2	16.95	0.0
7790C	7790Caa x A	C0, Syn 2	13,333	0.0	39.31	0.0	16.95	0.0
7767	6767aa x A		14,154	--	39.95	--	17.77	--
7776	6776aa x A(comp)		13,817	--	39.40	--	17.56	--
8755	NB C310aa x A		13,188	--	36.95	--	17.89	--
MEAN for synthetics			14,161		40.92		17.34	
Hybrids								
Y846H36	7790Laa x Y746	C4	16,554	6.0	47.62	6.7	17.43	-0.2
Y846H35	6790Kaa x Y746	C3	16,534	5.9	46.43	4.0	17.81	1.9
Y846H34	7790Faa x Y746	C2	116503	5.7	48.01	7.5	17.22	-1.4
Y846H33	7790Daa x Y746	C1	16,236	4.0	45.99	3.0	17.72	1.4
Y846H32	7790Caa x Y746	C0	15,612	0.0	44.65	0.0	17.46	0.0
Y846H67	7767aa x Y746		16,270	--	45.48	--	17.93	--
Y846H76	7776aa x Y746	16,265	--	45.95	--	17.69	--	
Y846H82	C310/6aa x Y746		15,401	--	43.45	--	17.73	--
MEAN for hybrids			16,172		45.95		17.62	
LSD (.05) for VxT			NS		2.6		NS	
C.V. (%)			5.9		5.9		2.9	
F value for treatments			50.7**		41.8**		10.8*	
F value for varieties			2.5*		3.5**		1.6NS	
F value for VxT			0.9NS		2.0NS		1.7NS	

[1]See summary for S_1 progeny evaluations.
[2]C# = Cycle of S_1 progeny recurrent selections; Syn# = Cycle of synthesis (recombination) through genetic ms (aa) segregates.

TEST 589. PERFORMANCE AND GCA OF C0:C1:C2:C3:C4 SYNTHETICS OF POPN-790, SALINAS, CA., 1989

8 entries x 2 treatments x 8 reps, SB
1-row plots, 30 ft. long

Planted: January 18, 1989
Harvested: September 27, 1989

Variety	Beets/ 100'	Sodium	Potassium	Amino Nitrogen	Impur. Value[1]	Recover. Sugar[1]
	No.	PPM	PPM	PPM		Lbs/Ton
Synthetics (Populations)						
8790L	129	567	1,580	618	11,808	311
6790K	125	611	1,675	651	12,523	304
7790F	120	562	1,591	663	12,248	306
7790D	119	584	1,635	716	12,941	300
7790C	110	589	1,805	749	13,695	297
7767	119	586	1,747	632	12,427	318
7776	125	550	1,866	740	13,627	310
8755	126	622	1,727	615	12,348	320
MEAN for synthetics	122	584	1,703	673	12,702	308
Hybrids						
Y846H36	121	624	1,800	679	13,139	309
Y846H35	120	523	1,727	611	11,956	320
Y846H34	124	547	1,789	653	12,598	306
Y846H33	131	596	1,719	635	12,421	317
Y846H32	126	600	1,875	673	13,186	309
Y846H67	121	528	1,817	572	11,836	323
Y846H76	125	550	1,722	646	12,372	316
Y846H82	126	585	1,807	615	12,420	317
MEAN for hybrids	124	569	1,782	635	12,491	315
LSD (.05) for VxT	9.2	NS	107.8	NS	1,097.4	11.0
C.V. (%)	7.4	17.6	6.2	12.8	8.7	3.5
F value for treatments	0.6NS	0.7NS	12.9**	2.8NS	0.7NS	16.8**
F value for varieties	1.0NS	0.4NS	2.5*	2.4*	1.5NS	1.9NS
F value for VxT	3.0*	0.8NS	4.2**	1.6NS	2.1NS	2.0NS

[1]Impurity value = 3.5 ppm Na + 2.5 ppm K + 9.5 ppm NH_2-N.
Sugar loss per ton of beets = (Impurity Value) (1.5) (0.002).

TEST 2289. PERFORMANCE AND GCA OF CO:C1:C2:C3:C4 SYNTHETICS OF POPN-790, SALINAS, CA., 1989

8 entries x 2 treatments x 8 reps, SB
2-row plots, 30 ft. long

Planted: February 22, 1989
Harvested: October 2, 1989

Variety	Description[1]	Cycle[2]	Acre Yield: Sugar Actual (Lbs)	Sugar Change (%)	Beets Actual (Tons)	Beets Change (%)	Sucrose Actual (%)	Sucrose Change (%)
Synthetics (Populations)								
790L	7790Laa x A	C4, Syn 2	12,559	25.2	37.29	19.2	16.81	5.1
6790K	4790Kaa x A	C3, Syn 2	11,777	17.4	36.10	15.4	16.31	2.0
7790F	1790Daa x A	C2, Syn 2	11,167	11.4	33.71	7.8	16.51	3.2
7790D	7790Daa x A	C1, Syn 2	11,812	17.8	35.59	13.8	16.58	3.6
7790C	7790Caa x A	CO, Syn 2	10,029	0.0	31.28	0.0	16.00	0.0
7776	6776aa x A		11,761	--	34.55	--	17.01	--
7767	6767aa x A		11,188	--	33.15	--	16.85	--
8755	NB C310 x A		11,024	--	32.47	--	16.94	--
MEAN for synthetics			11,415		34.27		16.63	
Hybrids								
Y846H36	7790Laa x Y746	C4	12,472	0.6	37.60	2.3	16.58	-1.6
Y846H35	6790Kaa x Y746	C3	12,929	4.3	38.15	3.8	16.92	0.4
Y846H34	7790Faa x Y746	C2	12,961	4.5	38.43	-4.6	16.84	-0.1
Y846H33	7790Daa x Y746	C1	12,218	-1.5	36.34	-1.1	16.82	-0.2
Y846H32	7790Caa x Y746	C0	12,401	0.0	36.75	0.0	16.86	0.0
Y846H67	7767aa x Y746		13,466	--	39.15	--	17.19	--
Y846H76	7776aa x Y746		13,395	--	38.79	--	17.25	--
Y846H82	C310/6 x Y746		13,361	--	37.74	--	17.69	--
MEAN for hybrids			12,900		37.87		17.02	
LSD (.05) for V x T			810		2.0		NS	
C.V. (%)			6.6		5.6		3.1	
F value for treatments			76.8**		33.5**		15.7**	
F value for varieties			0.7NS		0.8NS		2.4*	
F value for V x T			5.3**		5.0**		1.7NS	

[1]See summary for S_1 progeny evaluation.
[2]C# = cycle of S_1 progeny recurrent selection; Syn# = cycle of synthesis (recombination) through genetic ms (aa) segregates.

TEST 2289. PERFORMANCE AND GCA OF C0:C1:C2:C3:C4 SYNTHETICS OF POPN-790, SALINAS, CA., 1989
(continued)

8 entries x 2 treatments x 8 reps, SB
2-row plots, 30 ft. long

Planted: February 22, 1989
Harvested: October 2-3, 1989

Variety	Beets/ 100' No.	Sodium PPM	Potassium PPM	Amino Nitrogen PPM	Impur. Value[1]	Recover. Sugar[1] Lbs/Ton
Synthetics (Populations)						
8790L	136	694	1,377	625	11,818	300
6790K	131	664	1,410	605	11,607	291
7790F	130	685	1,383	613	11,683	295
7790D	124	609	1,414	690	12,227	294
7790C	116	798	1,642	606	12,664	282
7776	127	584	1,663	693	12,792	301
7767	121	665	1,551	568	11,611	302
8755	131	682	1,469	537	11,170	305
MEAN for synthetics	127	673	1,489	617	11,947	296
Hybrids						
Y846H36	126	846	1,407	585	12,048	295
Y846H35	122	744	1,476	527	11,313	304
Y846H34	125	660	1,411	541	10,982	303
Y846H33	118	821	1,424	542	11,585	301
Y846H32	119	722	1,553	613	12,245	300
Y846H67	127	629	1,605	530	11,254	310
Y846H76	131	641	1,457	527	10,896	312
Y846H82	131	612	1,519	526	10,941	321
MEAN for hybrids	125	709	1,482	549	11,408	306
LSD (.05) for VxT	7.4	119	114	NS	NS	NS
C.V. (%)	5.8	17.1	7.6	16.5	8.8	3.7
F value for treatments	0.4NS	2.7NS	0.04NS	10.0*	3.3NS	14.9**
F value for varieties	6.8**	1.8NS	5.3**	1.1NS	1.4NS	2.3*
F value for VxT	2.6*	3.2**	2.8*	1.6NS	1.4NS	1.7NS

[1]Impurity value = 3.5 ppm Na + 2.5 ppm K + 9.5 ppm NH_2-N.
Sugar loss per ton of beets = (Impurity Value) (1.5) (0.002).

TEST 1189. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1989

32 entries x 8 reps, RCB (equalized)
1-row plots, 30 ft. long

Planted: January 17, 1989
Harvested: September 28-29, 1989

Code	Variety	Source	Acre Yield		Sucrose	Bolters	Root Rot	Beets/ 100'
			Sugar Lbs	Beets Tons	%	%	%	No.
4F-22	HH41	Holly	15,457	48.14	16.06	0.8	0.0	132
4F-25	6BG6209	Betaseed	15,416	48.94	15.79	0.2	0.0	130
4F-21	86-84C25-020	Betaseed	15,239	45.48	16.78	0.0	0.0	140
4F-24	4757	Betaseed	15,172	46.52	16.36	0.0	0.2	136
4F-16	6BG6280	Betaseed	15,122	46.42	16.31	1.2	0.0	135
4F-17	86C15-014	Holly	15,075	44.24	17.09	0.3	0.0	136
4F-9	HH54	Holly	15,019	41.00	18.26	0.9	0.3	131
Y846H39	C762-17HOxC46/3	USDA	14,738	48.19	15.32	0.3	0.3	123
4F-3	H86461	Spreckels	14,715	44.06	16.71	0.0	0.0	131
4F-4	7BG6164	Betaseed	14,635	47.04	15.55	0.9	0.0	134
4F-15	861459-029	Holly	14,611	43.93	16.66	0.0	0.0	133
4F-26	H85207	Spreckels	14,601	44.77	16.35	0.8	0.0	134
4F-13	84C39-029	Holly	14,571	43.28	16.84	0.0	0.0	124
4F-1	88NB2	Spreckels	14,564	44.20	16.51	0.0	0.0	121
4F-11	H84181	Spreckels	14,547	45.79	15.92	0.0	0.0	133
4F-20	SS270	Spreckels	14,522	44.24	16.44	0.0	0.3	133
4F-19	USC-1	Holly	14,515	45.05	16.13	0.3	0.0	129
Y846H38	C312HO x C46/3	USDA	14,447	46.15	15.68	0.0	0.0	121
4F-8	HH37	Holly	14,429	44.67	16.13	0.0	0.0	133
4F-27	USC-5	Holly	14,295	44.16	16.19	0.0	0.0	127

TEST 1189. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1989
(continued)

Code	Variety	Source	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolters	Root Rot	Beets/ 100'
			Lbs	Tons	%	%	%	No.
Y846H70	C766-62HOxC46/3	USDA	14,139	44.40	15.94	0.3	0.0	114
4F-12	84C39-033	Holly	14,091	45.54	15.49	0.3	0.0	125
4F-23	4480	Betaseed	14,023	43.91	15.97	2.2	0.3	125
4F-6	USC-4	Holly	13,997	44.37	15.80	0.3	0.0	133
4F-7	Rhizosen	Holly	13,925	42.33	16.48	2.2	0.0	127
4F-5	H85333	Spreckels	13,901	42.05	16.53	0.6	0.0	137
4F-18	86-84C36-012	Holly	13,817	40.71	16.97	0.0	0.0	128
4F-2	SSNB3	Spreckels	13,716	42.56	16.15	0.0	0.0	129
4F-28	Hill-2	Hilleshog	13,618	41.33	16.46	0.3	0.0	126
Y846H66	C766-23HOxC46/3	USDA	13,366	42.35	15.79	0.0	0.0	118
4F-10	SSZ2	Spreckels	12,948	38.91	16.64	0.0	0.0	131
4F-14	SSZ1	Spreckels	12,743	39.74	16.04	0.0	0.4	116
MEAN			14,374	44.20	16.29	0.4	0.06	129
LSD (.05)			1,160	3.09	0.63	1.2	0.39	9.0
C.V. (%)			8.2	7.10	4.0	298.6	650.7	7.1
F value			2.5**	4.6**	6.2**	2.1**	0.9	4.0**

Notes: Entries Y846H39, Y846H38, Y846H70 & Y846H66 are fillers composed of USDA releases. No significant diseases were obvious. Moderate BWYV occurred from natural infection. Infestation of black aphids were controlled with methomyl; Green peach aphids by Metasystox-R. Powdery mildew controlled nearly completely by Bayleton. Seedling loss from tip-not (Pythium) occurred and appeared to be related to variety, e.g., entry 4F-14. Performance of this test is similar to commercial average in Cooper district.

TEST 1189. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1989
(continued)

32 entries x 8 reps, RCB (equalized)
1-row plots, 30 ft. long

Planted: January 17, 1989
Harvested: September 28-29, 1989

Code	Sodium PPM	Potassium PPM	Amino Nitrogen PPM	Impur. Value[1]	Impur. Index	Recover. Sugar[1] Acre	Recover. Sugar[1] %	Recover. Sugar[1] Lbs/Ton
4F-22	776	1,483	435	10,568	659	13,937	90.1	289
4F-25	928	1,442	429	10,936	692	13,828	89.6	282
4F-21	782	1,418	468	10,738	639	13,773	90.4	303
4F-24	818	1,498	495	11,317	694	13,599	89.5	293
4F-17	710	1,336	456	10,161	595	13,724	91.0	311
4F-9	763	1,265	409	9,730	561	13,829	91.8	335
Y846H39	878	1,627	449	11,410	748	13,107	88.7	272
4F-3	837	1,436	600	12,223	738	13,111	88.9	297
4F-4	883	1,476	479	11,337	734	13,033	88.9	276
4F-15	764	1,508	412	10,363	623	13,253	90.6	302
4F-26	756	1,597	487	11,275	692	13,087	89.6	293
4F-13	817	1,388	412	10,248	610	13,244	90.8	306
4F-1	681	1,464	586	11,620	704	13,025	89.4	295
4F-11	905	1,567	542	12,244	771	12,875	88.4	281
4F-20	737	1,477	508	11,101	676	13,050	89.8	295
4F-19	702	1,475	469	10,605	659	13,087	90.1	290
Y846H38	973	1,766	494	12,524	799	12,719	88.0	275
4F-8	844	1,448	476	11,106	690	12,945	89.6	289
4F-27	735	1,511	481	10,926	677	12,850	89.8	290
Y846H70	822	1,574	477	11,351	713	12,621	89.2	284

TEST 1189. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1989
(continued)

Code	Sodium PPM	Potassium PPM	Amino Nitrogen PPM	Impur. Value[1]	Impur. Index	Recover. Sugar[1] Acre	Recover. Sugar[1] %	Recover. Sugar[1] Lbs/Ton
4F-12	988	1,437	469	11,512	745	12,524	88.8	275
4F-23	1,013	1,512	502	12,102	761	12,432	88.5	283
4F-6	906	1,572	535	12,193	774	12,393	88.3	279
4F-7	772	1,377	436	10,296	627	12,617	90.5	298
4F-5	888	1,399	472	11,096	673	12,512	89.8	297
4F-18	711	1,443	490	10,756	635	12,503	90.4	307
4F-2	804	1,519	536	11,711	729	12,218	89.0	287
4F-28	845	1,575	493	11,584	706	12,189	89.4	294
Y846H66	962	1,597	493	12,047	768	11,840	88.4	279
4F-10	769	1,441	615	12,140	732	11,553	89.0	296
4F-14	968	1,545	620	13,150	822	11,188	87.6	281
MEAN	830	1,491	491	11,303	698	12,882	89.5	291
LSD (.05)	147	114	94	1,196	85	1,123	1.2	14.14
C.V. (%)	18.0	7.8	19.4	10.75	12.4	8.8	1.4	4.9
F value	3.0**	5.4**	2.7**	3.3**	4.1**	2.7**	4.1**	6.3**

[1]Impurity Value = 3.5 ppm Na + 2.5 ppm K + 9.5 ppm NH_2-N.
Sugar loss per ton of beets = (Impurity value) (1.5) (0.002)

TEST 1689. NONINOCULATED YELLOWS (BYV) EVALUATION OF MONOGERM, SELF-FERTILE GERMPLASM, SALINAS, CA., 1989

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 21, 1989
Harvested: October 19-20, 1989
Not Inoculated [1]

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' [2] No.	RJAP %	Powdery Mildew [2,3] Rating
88-790-68H26	C309CMS x C790-68	11,362	34.87	16.31	0.0	133	82.3	5.3
8790	7790Laa x A(C790)	11,302	37.49	15.07	0.0	136	81.4	3.9
8743	7743aa x A (C789/2)	10,617	31.84	16.74	0.0	133	80.5	3.6
Y854	Inc. Y654 (C54)	10,290	32.85	15.74	0.0	131	79.8	3.1
8857	RZM 7224,5 (A,aa)	10,276	33.19	15.48	1.3	97	79.7	4.9
8856	RZM 7228 (A,aa)	10,081	31.98	15.77	0.3	124	78.8	3.5
8787	7755-7797aa x A	9,960	34.60	14.41	0.0	134	78.6	3.8
88-790-68H92	C796-22 x C790-68	9,872	32.34	15.31	0.0	126	80.4	3.6
8863	RZM 7226 (A,aa)	9,869	32.03	15.35	0.0	126	78.7	4.4
8776	NB 6776 (A,aa)	9,596	30.90	15.61	0.3	133	78.9	3.4
6756	5756 Zaa x A(C310/6)	9,340	29.84	15.79	0.0	141	80.9	3.0
8755	7755,6aa x A(C310)	8,949	29.20	15.52	0.0	135	78.5	3.3
8767	NB 6767 (A,aa)	8,329	28.01	14.96	0.0	135	78.7	3.0
F82-546H3	(82460)C562CMS x C546	8,230	30.21	13.66	0.0	117	79.5	6.8
8858	RZM 7230 (A,aa)	8,218	25.38	16.17	0.0	99	75.6	4.4
8796	7796aa x A (C796)	8,057	28.80	14.00	0.0	124	77.2	3.8
MEAN		9,647	31.47	15.37	0.1	126	79.3	4.0
LSD (.05)		1,572	4.64	1.25	NS	10.1	NS	0.8
C.V. (%)		11.4	10.30	5.70	590.4	8.1	3.20	20.7
F value		3.7**	3.3**	3.5**	1.7NS	12.2**	1.6NS	11.5**

[1] BYV inoculated and % loss are summarized on the following page.
[2] Means over both virus treatments.
[3] PM rating 8/20/89.

TEST 1689. BYV INOCULATED EVALUATION OF MONOGERM, SELF-FERTILE GERMPLASM, SALINAS, CA., 1989

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 21, 1989
Harvested: October 19-20, 1989
BYV Inoculated: May 12, 1989

Variety[4]	Sugar Yield Inoc.	Sugar Yield Loss	Beets Yield Inoc.	Beets Yield Loss	Sucrose Inoc.	Sucrose Loss	RJAP	Mean Yellows
	Lbs/A	%	Tons/A	%	%	%	%	Rating
88-790-68H26	7,824	30.8	26.61	23.2	14.73	9.7	78.4	4.2
Y854	7,702	24.7	27.23	15.7	14.18	9.5	78.7	3.8
8743	7,584	28.5	25.06	20.6	15.11	9.5	78.3	4.3
8787	7,356	25.8	25.53	26.1	14.43	-0.8	77.6	4.2
8790	7,351	34.6	26.37	29.4	13.96	6.8	77.5	4.1
88-790-68H92	7,185	25.3	25.00	21.0	14.34	6.3	77.6	4.2
6756	7,134	22.7	24.97	14.8	14.29	9.1	78.3	4.7
8863	7,056	27.7	24.12	24.5	14.64	4.3	77.2	4.6
8857	6,984	30.6	24.04	26.2	14.51	6.2	76.8	4.7
8767	6,863	17.1	23.08	16.7	14.80	0.8	78.3	4.6
8856	6,801	31.5	22.90	27.8	14.86	5.4	77.7	4.6
8755	6,629	25.4	23.43	17.3	14.13	8.5	77.1	4.7
8776	5,845	37.7	20.47	31.4	14.26	8.4	78.7	4.3
F82-546H3	5,618	30.9	22.22	25.9	12.71	6.3	79.4	4.8
8796	5,502	31.8	20.78	27.7	13.23	5.5	77.6	4.2
8858	4,720	42.0	16.34	35.5	14.46	10.3	76.7	5.4
MEAN	6,760	29.2	23.63	24.0	14.29	6.6	77.9	4.4
LSD (.05)	815	NS	2.55	NS	1.08	NS	NS	0.5
C.V. (%)	8.5	33.0	7.60	37.7	5.30	121.1	3.0	8.1
F value for varieties	8.8**	1.5NS	8.4**	1.7NS	5.4**	0.6NS	1.1NS	9.4**
F value for virus treatment	77.5**	--	26.5*	--	28.9**	--	37.3**	--
F value for variety x virus	1.1NS	--	1.0NS	--	0.8NS	--	0.6NS	--

[4] For description see previous page.
[5] Mean virus yellows scores from 6/21, 6/28, 7/5, 7/11, and 7/18/89. Scored from 0 = no symptons to 9 = 100% of matured leaf canopy yellowed.

TEST 1789. NONINOCULATED YELLOWS (BYV) EVALUATION OF MULTIGERM, SELF-FERTILE GERMPLASM, SALINAS, CA., 1989

Split-block with 4 replications
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 22, 1989
Harvested: October 20, 1989
Not Inoculated [1]

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
8906	RZM 7906,7 aa x A	14,472	44.91	16.20	0.5	108	80.5	4.8
8910	RZM 7238 (A,aa)	14,165	42.56	16.74	0.4	107	81.3	4.4
8911	RZM 7239 (A,aa)	13,348	39.85	16.75	0.0	109	81.3	3.3
8908	RZM 7908 (A,aa)	13,189	40.73	16.23	0.0	107	81.6	4.6
8909	7909,7239aa x A	12,917	39.25	16.50	0.7	112	82.1	2.4
8904	YR-ER-PMR 6904 (A,aa)	12,542	38.56	16.26	0.0	117	82.8	3.1
Y854	Inc. Y654	12,159	37.19	16.35	0.0	123	83.0	3.3
7903	6903aa x A	11,427	36.47	15.65	0.0	131	83.4	3.3
MEAN		13,027	39.94	16.33	0.2	114	82.0	3.6
LSD (.05)		NS	NS	NS	NS	11.6	NS	1.2
C.V. (%)		10.7	11.70	4.00	458.2	10.1	3.5	32.6
F value		2.1NS	1.4NS	1.2NS	0.8NS	4.5**	0.5NS	4.1**

[1] BYV inoculated and % loss are summarized on the following page.
[2] Means over both virus treatments.
[3] PM rating 8/20/89.

TEST 1789. BYV INOCULATED EVALUATION OF MULTIGERM, SELF-FERTILE GERMPLASM, SALINAS, CA., 1989

Split-block with 4 replications
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 22, 1989
Harvested: October 20, 1989
BYV Inoculated: May 12, 1989

Variety[4]	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows Rating
8906	10,509	27.2	33.79	23.9	15.54	3.8	81.4	4.4
8910	9,805	30.7	32.79	22.2	14.95	10.5	80.8	4.3
8909	9,790	25.2	31.82	20.6	15.45	4.6	81.3	4.2
8911	9,606	27.0	30.68	21.9	15.68	6.4	80.2	3.9
8909	9,596	24.9	31.31	19.5	15.32	7.0	82.7	3.7
Y854	9,466	21.0	30.43	17.1	15.61	4.5	82.2	4.1
7903	8,730	21.9	29.17	18.8	14.98	4.2	81.7	3.1
8904	8,259	33.7	28.60	25.5	14.52	10.7	81.0	3.5
MEAN	9,470	26.4	31.08	21.2	15.26	6.5	81.4	3.9
LSD (.05)	1,307	NS	NS	NS	NS	NS	NS	0.6
C.V. (%)	11.5	51.9	13.20	74.3	4.00	87.2	3.8	10.7
F value for varieties	3.1*	0.4	2.0NS	0.1	1.8NS	1.0	0.5NS	4.4**
F value for virus treatment	342.0**	--	700.4**	--	56.5**	--	0.8NS	--
F value for variety x virus	0.5NS	--	0.2NS	--	1.1NS	--	0.2NS	--

[4] For description see previous page.
[5] Mean virus yellows scores from 6/21, 6/28, 7/5, 7/11, and 7/18/89. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

TEST 1889. NONINOCULATED YELLOWS (BYV) EVALUATION OF MULTIGERM, O.P. GERMPLASM, SALINAS, CA., 1989

Split-block with 4 replications
32 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 22, 1989
Harvested: November 6-7, 1989
Not Inoculated[1]

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
R876	RZM 7259 (C31R$_z$)	13,464	42.04	16.01	0.0	93	81.7	1.4
R877	RZM 7257 (C92R$_z$)	12,394	39.36	15.80	0.0	103	78.9	2.8
R839(C4)	RZM R739(C3)(C39/R4)	12,028	39.65	15.11	0.0	97	81.0	0.8
R839(C3)	Inc. R739(C3)	11,912	37.75	15.81	0.0	110	83.0	1.5
R871	RZM R771 (C31R$_z$)	11,802	39.16	15.18	0.6	66	80.0	2.6
8102(C12T)	YR-ER-PMR 6102	11,742	35.76	16.41	0.0	115	82.8	1.9
R873	Inc. R773,7261 (C46R$_z$)	11,568	38.52	15.04	0.0	105	80.9	1.6
Y854H24	87-309H92 x Y654	11,345	37.63	15.06	0.0	127	83.1	5.0
Y849	YR-ER-PMR Y649 (C49)	11,296	35.59	15.89	0.4	122	81.8	2.1
Y854(C54)	YR-ER-PMR Y654 (C54)	11,247	35.33	15.93	0.0	122	83.5	2.8
R875	RZM 7258 (C54R$_z$)	10,794	33.28	16.21	0.0	92	80.5	2.1
Y854H68	7767HO x Y654	10,679	37.48	14.16	0.0	124	80.8	3.0
8101(C11T)	YR-ER-PMR 6101	10,554	33.46	15.73	0.0	111	85.3	1.8
R878	RZM 7261 (C46R$_z$)	10,520	36.08	14.60	0.0	98	80.8	1.8
R818(C50)	RZM R718 (Y54 x B.M.)	10,461	36.68	14.11	0.0	122	79.0	3.8
Y854	Inc. Y654	10,189	33.89	14.88	0.0	112	82.6	3.4
P1,5[6]	Acc.Poland	10,063	28.28	17.89	3.1	89	82.9	2.6
Y846	YR-ER-PMR Y646 (C46/4)	9,801	33.31	14.69	0.0	126	81.5	1.4
U86-46/2	Inc. C46/2 (C46/2)	9,707	33.15	14.43	0.0	112	81.1	2.4
Y857	YR-ER-PMR Y657	9,457	32.04	14.71	0.0	112	81.1	4.0

TEST 1889. NONINOCULATED YELLOWS (BYV) EVALUATION OF MULTIGERM, O.P. GERMPLASM, SALINAS, CA., 1989
(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
R847(C3)	Inc. R747(C3)	9,419	32.51	14.36	0.0	121	81.5	3.0
P6,9	Acc.Poland	9,365	28.80	16.14	1.4	80	82.7	4.0
R820(C94)	RZM R720	9,311	39.23	11.91	0.0	104	80.1	3.1
R874	RZM R774 ($C37R_Z$)	9,151	31.93	14.43	0.5	98	77.2	3.4
U86-37	Inc. C37	8,997	30.57	14.79	0.0	117	82.6	3.9
F86-31/6	Inc. C31/6	8,919	33.37	13.35	0.0	101	80.4	1.9
SP7622-0	SP22-0,L80466	8,748	31.91	13.66	0.0	121	82.3	4.3
R879	RZM 7263 ($C37R_Z$)	8,586	28.61	14.99	0.0	112	77.9	3.8
R824(C48)	RZM(C37*3 x W841,42)	8,552	30.57	13.84	0.0	119	81.3	4.1
R847(C4)	RZM R747(C3) (C47R4)	8,299	32.75	12.60	0.0	114	80.7	3.9
Y853	YR-ER-PMR Y653	8,205	28.06	14.57	0.4	105	82.4	2.1
768	Inc. 868(US75)	8,205	31.78	12.79	0.0	97	80.5	5.4
MEAN		10,212	34.33	14.85	0.2	107.7	81.3	2.9
LSD (.05)		2,672	7.85	1.43	0.9	13.5	NS	1.4
C.V. (%)		18.6	16.30	6.80	458.9	12.7	3.3	49.5
F value		2.1**	1.8**	5.8**	3.5**	8.5**	1.6NS	5.2**

[1] BYV inoculated and % loss are summarized on the following pages.
[2] Means over both virus treatments.
[3] PM rating 8/20/89.
[6] P1-5 = 1988 2n Polish accessions 1 thru 5; P6-9 = 1988 2n Polish accessions 6 thru 9. Each accession tested in one BYV inoc vs. noninoculated replication where % S = P1 (17.00, 16.65); P2 (13.25, 18.65); P4 (17.55, 19.00); P5 (15.35, 17.25); P6 (17.25, 16.00); P7 (15.15, 18.00); P8 (12.00, 14.00); & P9 (13.25, 16.55).

TEST 1889. BYV INOCULATED EVALUATION OF MULTIGERM, O.P. GERMPLASM, SALINAS, CA., 1989

Split-block with 4 replications
32 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 22, 1989
Harvested: November 6-7, 1989
BYV Inoculated: May 12, 1989

Variety[4]	Sugar Yield Inoc. Lbs/A	Loss %	Beets Yield Inoc. Tons/A	Loss %	Sucrose Inoc. %	Loss %	RJAP %	Mean Yellows Rating
R871	10,494	8.7	34.55	8.4	15.20	- 0.4	81.1	4.0
Y854H68	10,224	- 3.9	36.68	- 3.4	13.93	0.2	83.1	4.2
R847(C4)	9,459	-18.5	34.26	- 6.5	13.65	- 9.6	79.9	3.3
R876	9,380	30.2	30.29	27.8	15.54	2.8	81.8	3.2
Y854H24	9,340	17.9	33.19	11.9	14.02	6.8	81.0	4.6
R875	9,281	12.8	31.67	3.8	14.68	9.2	81.0	4.0
R878	9,250	10.9	31.61	11.3	14.65	- 0.4	80.6	4.1
R839(C4)	8,790	22.1	32.00	15.5	13.68	9.3	79.5	3.9
F86-31/6	8,738	2.5	31.39	5.7	13.81	- 3.6	81.5	3.1
R818(C50)	8,718	14.4	33.32	9.3	13.10	5.5	76.6	3.9
Y854(C54)	8,568	20.0	29.35	12.7	14.59	8.3	81.4	4.2
R839(C3)	8,507	28.6	30.35	18.9	13.95	11.7	80.6	3.9
Y857	8,443	9.5	28.97	9.0	14.56	0.8	80.2	4.1
Y849	8,437	24.1	28.82	17.3	14.65	7.6	82.3	3.3
Y854	8,101	13.3	28.19	13.8	14.25	2.7	80.6	4.3
R877	8,053	34.9	27.09	30.5	14.80	6.2	80.9	3.5
8102(C12T)	8,010	31.4	24.83	30.5	16.13	1.7	84.4	5.5
R879	7,791	9.0	26.06	8.7	14.98	0.1	78.4	3.7
R847(C3)	7,767	13.4	29.52	6.2	13.10	8.4	80.3	3.5
R873	7,545	33.4	26.59	29.6	14.14	5.9	76.7	4.5

TEST 1889. BYV INOCULATED EVALUATION OF MULTIGERM, O.P. GERMPLASM, SALINAS, CA., 1989
(continued)

Variety[4]	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons/A	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows Rating
R874	7,158	21.7	25.42	20.1	14.07	1.8	77.0	4.5
Y853	7,012	11.5	23.57	13.0	14.82	-1.8	80.6	5.4
Y846	6,849	29.2	23.75	26.4	14.30	2.7	80.8	4.2
R824(C48)	6,620	16.9	24.57	16.5	13.44	2.3	78.4	3.4
8101(C11T)	6,475	36.8	23.02	29.9	13.98	10.7	80.9	5.6
U86-46/2	6,279	28.0	22.63	27.8	13.80	3.3	81.9	4.5
R820(C94)	6,188	33.4	25.87	29.6	11.95	5.9	77.1	5.1
U86-37	6,007	30.6	23.35	19.2	12.79	13.4	79.8	3.3
P1,5	5,693	43.6	17.78	36.8	15.79	11.4	83.4	5.2
P6,9	5,462	40.2	19.73	29.3	13.71	14.9	78.8	5.3
768	4,253	46.0	22.97	26.0	9.27	27.3	75.6	4.9
SP7622-0	3,805	57.2	18.54	41.9	10.16	25.5	78.1	5.6
MEAN	7,709	22.2	27.50	18.2	13.92	5.7	80.1	4.2
LSD (.05)	1,848	28.6	5.06	25.3	1.53	14.5	4.2	0.6
C.V. (%)	17.1	91.7	13.10	99.0	7.80	179.6	3.8	10.5
F value for varieties	5.2**	2.3**	5.3**	1.7*	10.5**	2.2**	2.5**	4.7**
F value for virus treatment	224.3**	--	179.7**	--	11.4*	--	5.4NS	--
F value for variety x virus	1.6*	--	1.4NS	--	2.0**	--	1.0NS	--

[4] For description see previous pages.
[5] Mean virus yellows scores from 6/21, 6/28, 7/5, 7/11 and 7/18/89. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

TEST 2089. NONINOCULATED YELLOWS (BYV) EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1989

Split-block with 4 replications
32 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 22, 1989
Harvested: October 18-19, 1989
Not Inoculated [1]

Variety	Description[4]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
HH41	Holly L41330	14,823	42.86	17.34	0.0	114	82.1	3.1
Y846H85	C790-92HO x Y746	14,484	43.49	16.61	0.0	123	84.5	4.0
Y854H66	C766-23HO x Y654	14,446	42.19	17.06	0.4	125	84.4	4.6
Y846H89	C790-68HO x Y746	14,441	43.40	16.61	0.0	126	84.4	2.4
4757	Betaseed	14,346	42.79	16.79	0.0	122	83.5	2.5
Y731H26	87-309CMS x F86-31/6	14,219	41.04	17.33	0.0	123	83.6	11.3
Y846H105	7855aa x Y746	14,183	41.60	17.06	0.0	122	82.8	3.3
Y731H89	C790-68HO x F86-31/6	14,142	41.46	17.10	0.0	114	85.1	2.9
Y846H39	C762-17HO x Y746	14,059	42.27	16.61	0.0	116	84.2	1.3
Y854H26	87-309CMS x Y654	13,952	40.82	17.08	0.0	127	82.3	5.3
Y854H89	C790-68HO x Y654	13,875	39.20	17.76	0.0	122	82.0	2.4
Y731H42	C742-24HO x F86-31/6	13,583	38.94	17.52	0.0	106	83.0	1.6
Y846H117	7230aa x Y746	13,564	39.25	17.25	0.0	112	84.3	3.0
Y846H3	F82-452HO x Y746	13,538	39.02	17.34	0.0	1123	83.9	3.4
Y846H97	C796-43HO x Y746	13,494	39.97	16.95	0.0	118	83.1	2.6
Y854H70	C766-62HO x Y654	13,385	41.06	16.29	0.0	120	83.3	4.5
Rhizosen	L49302, Holly	13,362	39.17	17.11	0.0	102	83.1	4.0
Y846H92	F85-796-22CMS x Y746	13,330	39.39	16.99	0.0	112	83.6	2.4
Y731H70	C766-62HO x F86-31/6	12,961	38.68	16.73	0.4	106	82.6	3.9
Y846H61	7766-8HO x Y746	12,909	40.64	15.81	0.4	123	84.5	3.9

TEST 2089. NONINOCULATED YELLOWS (BYV) EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1989
(continued)

Variety	Description[4]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
6625	Betaseed	12,894	35.31	18.25	0.3	118	83.0	2.8
Y846H24	87-309H92 x Y746	12,741	38.02	16.77	0.0	123	82.9	3.3
Y846H24	87-309H92 x Y746	12,667	37.10	17.05	0.0	122	83.8	4.1
SS NB3	Spreckels	12,649	37.06	17.02	0.0	104	81.7	4.4
Y846H66	C766-23HO x Y746	12,646	38.74	16.30	0.0	127	82.3	3.0
Y854H8	F82-546H3 x Y654	12,360	36.61	16.86	0.0	123	83.6	4.4
Y846H26	87-309CMS x Y746	12,292	36.21	16.96	0.0	128	83.7	4.3
Y846H20	87-309H3 x Y746	12,080	35.01	17.17	0.0	123	83.1	2.9
US H11	786442, 546H3 x C36	12,039	38.83	15.50	0.0	123	82.3	5.1
N801H(B)	Blend CMS x B883	11,834	44.97	13.14	0.0	138	79.9	6.5
Y846H38	6827HO(C312) x Y746	11,551	35.94	16.00	0.0	119	81.0	3.1
Y846H62	7766-14HO x Y746	11,275	35.96	15.65	0.0	120	82.3	2.9
MEAN		13,254	39.59	16.75	0.04	119.5	83.1	3.5
LSD (.05)		NS	NS	0.87	NS	9.8	NS	1.1
C.V. (%)		13.4	12.70	3.70	761.7	8.3	3.2	32.8
F value		1.1NS	1.1NS	8.0**	1.0NS	4.8**	0.7NS	7.4**

[1]BYV inoculated and % loss are summarized on the following page.
[2]Means over both virus treatments.
[3]PM rating 8/20/89.
[4]HO = CMS. aa = genetic ms. 309H92 = C796-22 x C309. C309H3 = C562 x C309.
Y746 = C46/3 (reselection from C46/2). Y654 - predecessor of C54 (C54 = reselection for VYR from Y654).

TEST 2089. BYV INOCULATED EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1989

Split-block with 4 replications
32 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 22, 1989
Harvested: October 18-19, 1989
BYV Inoculated: May 12, 1989

Variety[5]	Sugar Yield		Beets Yield		Sucrose		RJAP	Mean Yellows[6]
	Inoc.	Loss	Inoc.	Loss	Inoc.	Loss		
	lbs/A	%	Tons/A	%	%	%	%	Rating
Y731H26	11,390	19.9	34.35	16.4	16.48	4.8	82.4	3.5
Y731H42	11,383	15.3	33.29	12.5	17.10	2.2	93.3	3.9
Y731H89	11,341	19.8	34.21	17.4	16.66	2.6	86.4	3.8
Rhizosen	10,399	22.0	31.74	18.5	16.35	4.3	96.2	4.7
Y854H89	10,357	24.7	33.06	13.7	15.63	11.9	82.9	3.8
Y846H70	10,329	17.3	32.86	10.3	15.71	7.8	84.5	3.7
Y846H26	10,115	15.9	31.73	10.4	16.00	5.6	80.4	4.3
Y731H70	10,109	20.0	31.98	16.1	15.81	5.2	84.3	3.5
Y846H61	10,034	19.6	32.31	18.6	15.45	2.2	84.1	3.9
Y846H105	10,025	28.7	31.23	24.4	16.10	5.7	78.3	4.2
HH41	9,935	32.8	31.39	26.2	15.81	8.7	83.4	4.3
Y854H70	9.880	24.3	31.29	22.2	15.77	3.1	82.2	4.0
Y846H85	9,710	31.3	31.72	26.3	15.27	7.7	82.6	3.7
Y846H66	9,697	20.0	30.72	18.2	15.74	3.2	84.2	4.3
Y846H24	9,654	23.8	30.29	19.5	15.93	4.9	82.1	4.2
4757	9,591	32.8	31.47	26.1	15.23	9.3	80.5	4.5
Y846H92	9,543	26.5	28.32	25.8	16.81	0.9	82.4	4.2
Y846H38	9,322	16.7	30.09	15.0	15.51	2.8	83.3	4.4
Y846H3	8,158	31.4	29.37	24.1	15.61	9.8	81.3	4.4
Y846H20	9,107	22.9	29.39	15.0	15.51	9.4	82.4	4.2

TEST 2089. BYV INOCULATED EVALUATION OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1989
(continued)

Variety[5]	Sugar Yield		Beets Yield		Sucrose		RJAP	Mean Yellows[6]
	Inoc. Lbs/A	Loss %	Inoc. Tons/A	Loss %	Inoc. %	Loss %	%	Rating
Y854H26	9,058	35.0	29.96	26.6	15.04	11.7	80.9	4.3
Y846H117	8,991	33.4	29.99	23.4	14.99	12.9	79.2	4.4
US H11	8,910	24.8	29.41	23.2	15.14	2.3	82.7	4.1
Y846H39	8,909	35.7	29.93	28.3	14.88	10.4	82.1	4.5
Y854H8	8,800	24.3	29.32	15.6	14.95	11.4	82.6	4.3
Y846H89	8,729	38.0	27.55	35.4	15.84	4.6	83.0	4.2
Y854H66	8,719	20.0	27.81	18.2	15.59	3.2	81.4	4.6
Y846H62	8,682	22.0	29.14	18.4	14.89	4.6	81.7	3.6
6625	8,654	32.0	25.28	27.4	17.13	6.2	84.4	5.8
SS NB3	8,561	31.2	27.28	26.1	15.71	7.4	83.6	4.5
Y846H97	8,188	39.7	36.32	34.1	15.49	8.5	82.8	4.4
N801H(B)	7,917	33.3	31.67	29.4	12.44	5.5	77.4	4.5
MEAN	9,538	26.5	30.45	21.8	15.64	6.4	82.5	4.2
LSD (.05)	1,715	NS	4.76	NS	1.10	NS	4.0	0.6
C. V. (%)	12.8	53.7	11.10	63.8	5.00	93.1	3.5	10.0
F value for varieties	1.9**	1.0NS	1.6*	0.9NS	10.5**	1.2NS	1.6*	4.1**
F value for virus treatment	73.7**	--	61.8**	--	36.2**	--	17.7**	--
F value for variety x virus	1.0NS	--	0.9NS	--	1.4NS	--	1.0NS	--

[5]For descriptions see previous page.
[6]Mean virus yellows scores from 6/21, 6/28, 7/5, 7/11 and 7/18/89. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

TEST 2189. NONINOCULATED YELLOWS (BYV) EVALUATION OF POPULATION HYBRIDS, SALINAS, CA., 1989

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 22, 1989
Harvested: November 7, 1989
Not Inoculated [1]

Variety	Description[4]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
HH41	Holly L41330	16,122	47.29	17.02	0.0	125	85.4	3.1
Y846H76	7776aa x Y746	15,570	44.90	17.34	0.0	131	85.7	2.5
R839H68	7767HO x R739C3	14,974	44.47	16.77	0.0	124	85.1	2.4
Y846H36	C790Laa x Y746	14,781	44.11	16.74	0.0	136	85.0	2.1
7906H68	6767HO x 6235,6,7	14,570	44.60	16.30	0.0	124	85.5	4.3
Y731H67	6767aa x F86-31/6	14,215	42.23	16.86	0.0	125	85.4	2.8
R847H68	7767HO x R747	14,165	42.92	16.45	0.0	132	83.7	3.8
R873H68	7767HO x R773	14,151	44.55	15.88	0.0	122	83.1	2.5
6625	Betaseed	14,077	37.69	18.67	1.4	122	85.0	2.8
Y854H68	7767HO x Y654	14,031	42.74	16.40	0.0	126	85.8	3.3
8909H68	7767HO x 7909	13,917	42.39	16.44	0.0	120	84.8	3.4
Y846H68	F82-546H3 x Y746	13,462	41.83	16.08	0.0	127	83.7	2.9
Y846H68	7767HO x Y746	13,396	41.99	15.84	0.0	127	84.9	2.4
Y846H82	6756(C310/6)aa x Y746	13,189	39.27	16.83	0.0	125	84.2	2.4
Y846H114	7224,5aa x Y746	12,531	37.88	16.45	0.0	130	84.5	2.5
Y846H96	C796aa x Y746	11,370	35.68	15.82	0.0	127	81.7	3.0
MEAN		14,033	42.16	16.62	0.1	126	84.6	2.9
LSD (.05)		2,204	5.15	1.03	NS	8.9	NS	1.2
C.V. (%)		11	8.60	4.40	1,131.4	7.1	2.7	42.1
F value		2.2	3.0**	3.7**	1.0NS	1.8*	0.9NS	1.8*

[1]BYV inoculated and % loss are summarized on the following page.
[2]Means over both virus treatments.
[3]PM rating 8/20/89.
[4]HO = CMS; aa = genetic ms. Females are mm,S^f,A:aa populations undergoing population improvement.

TEST 2189. BYV INOCULATED EVALUATION OF POPULATION HYBRIDS, SALINAS, CA., 1989

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 22, 1989
Harvested: November 7, 1989
BYV Inoculated: May 12, 1989

Variety[5]	Sugar Inoc. Lbs/A	Yield Loss %	Beets Inoc. Tons/A	Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[6] Rating
Y731H67	10,677	24.5	35.26	15.7	15.07	10.6	84.4	4.0
8909H68	10,163	26.9	33.33	21.0	15.21	7.4	83.1	4.2
R839H68	10,157	29.2	34.01	21.7	14.93	10.5	82.7	4.1
R847H68	10,079	25.9	33.57	20.1	14.88	9.3	84.4	4.0
Y854H68	10,076	28.2	33.06	22.8	15.27	6.7	84.3	4.2
Y846H82	9,669	25.0	30.61	20.2	15.75	6.3	84.7	4.4
R873H68	9,430	32.3	31.18	29.1	15.09	4.9	82.1	4.5
Y846H114	9,226	23.1	31.01	16.2	14.81	9.7	84.1	4.2
Y846H68	9,188	29.3	31.57	23.2	14.56	8.0	85.2	4.3
Y846H96	9,163	17.9	31.13	11.9	14.70	6.9	83.9	3.9
7906H68	9,116	36.1	30.64	30.4	14.88	8.7	83.4	4.6
Y846H76	8,871	43.2	30.81	31.5	14.35	17.3	83.5	3.5
HH41	8,530	46.9	29.96	36.2	14.15	16.8	81.7	4.1
Y846H36	8,271	43.7	28.55	35.1	14.40	13.9	83.1	4.3
6625	8,140	41.9	24.01	36.0	16.94	9.3	85.4	4.9
Y846H8	7,891	42.0	26.50	37.0	14.71	8.5	84.2	4.2
MEAN	9,290	32.3	30.95	25.5	14.98	9.7	83.8	4.2
LSD (.05)	NS	NS	5.18	16.7	1.33	NS	NS	0.5
C.V. (%)	16.1	44.0	11.70	46.0	6.20	67.7	3.0	9.1
F value for varieties	1.6NS	1.6NS	3.4**	1.9**	4.1**	1.2NS	0.8NS	2.6**
F value for virus treatment	58.1**	--	38.6**	--	68.7**	--	0.8NS	--
F value for variety x virus	1.8*	--	2.0*	--	1.1NS	--	0.8NS	--

[5]For description see previous page.
[6]Mean virus yellows scores from 6/21, 6/28, 7/5, 7/11 and 7/18/89. Scored from 0 = no sumptoms to 9 = 100% of matured leaf canopy yellowed.

BYV-5. BEET YELLOWS VIRUS INOCULATED YIELD TEST, DAVIS, CA. 1989

16 varieties x 6 reps.
1-row plots, 30 ft. long, 30" rows

Planted: May 3, 1989
Inoc. BYV: June 16, 1989
Harvested: October 13, 1989

Variety	Description[1]	Acre Yield Sugar Lbs.	Beets Tons	Sucrose %
Y731H89	C790-68CMS x C31/6	8,889	35.34	12.5
Y731H42	C742-24CMS x C31/6	8,310	33.79	12.3
4587	Betaseed	8,305	22.72	12.7
Y731H76	776aa x C31/6	8,008	31.80	12.6
Y854H26	C309CMS x Y654	7,871	30.57	12.9
Y854H70	C766-62CMS x Y654	7,702	32.00	12.0
Y731H26	C309CMS x C31/6	7,672	30.24	12.7
Y846H39	C762-17CMS x Y746	7,537	32.50	11.5
Y846H38	C312CMS x Y746	7,379	30.20	12.2
Y731H20	C309H3 x C31/6	7,340	29.44	12.4
Y846H26	C309CMS x Y746	7,287	28.48	12.8
Y854H66	C766-23CMS x Y654	7,117	29.12	12.2
Y846H97	C796-43CMS x Y746	6,950	27.95	12.4
SS-NB3	Spreckels	6,834	29.00	11.8
Y846H70	C766-62CMS x Y746	6,652	29.50	11.2
Y846H66	C766-23CMS x Y746	6,252	25.79	12.1
Mean		7,507	30.53	12.3
LSD (.05)		1,186	4.07	0.8
CV (%)		13.7	11.6	5.7
F value		2.6**	2.8**	2.7**

Test by Dr. Steve Temple, UC Davis.

[1] Y654 = early version of C54; Y746 = reselection of C46/2. 776 = monogerm, self-fertile, A:aa population selected for VY resistance. C309H3 = C562CMS x C309.

C31/6 is source population of half-sib families tested under BYV inoculated conditions at Davis and Salinas in 1988. Selected lines and synthetics and their experimental hybrids will be evaluated for yield and BYV resistance at Salinas and Davis in 1990.

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1988-89

USDA-ARS, Irrigated Desert Research Station

Tests were located in 90 beds in the middle of block K. Rotation included sugarbeet in 1985-86 and cereals in 1987-88. All fertilizer was applied preplant as 46:0:0 and 11:52:0 for a total of 153 units of N and 165 units of P_2O_5.

Summary: Arrangement of 1988-89 Tests

Test No.	Entries per Test	No. Reps.	Rows per Plot[1]	Plot Length (ft)	Harv. Date	Test Design
B189	20	10	1	40	May 22	RCB
B289[2]	24	10	1	40	May 23	RCB
B389	100	3	1	12	May 24	RCB[3]
B489	32	8	1	24	May 19	RCB
B589	16	8	1	24	May 18	RCB

[1] Rows 30" wide.
[2] Area 5 Coded Variety Trial.
[3] 10 x 10 x 3 triple lattice.

Seeding Date: September 20, 1988.

Irrigations: Sprinkled 9/21, 9/29; Furrowed 10/24/88, 11/22, 12/15, 1/19/89, 2/14, 3/8, 3/27, 4/10, 4/24, & 5/8.

Thinned: October 12-13, 1988.

Herbicide: None.

Disease and Insect Control: Lorsban at 1.5 pints/A on October 30. Sulfur at 40 lbs/A on April 3 for powdery mildew.

Remarks: On tests B289 and B589, 2 sugar samples per plot were taken. Only 1 sample per plot was taken for B189, B389, and B489. Components of impurity were measured only for tests B189, B289, & B389. Tests were obviously under high nitrogen status and were harvested wet. Sugars were very low but appeared to be relatively accurate.

The high nitrogen status and leaf feeding activity of mites and Empoasca masked obvious visual differences among lines for reaction to LIYV. But based upon whitefly activity, infection in other crops, and the performance of check varieties, LIYV infection was probably severe. There was no obvious correlation between canopy color and apparent reaction to LIYV. Rather differences in color may have been due to differential feeding to insects and mites.

Other than severe infection by LIYV, no other diseases were severe. Powdery mildew occurred in late March and was controlled in early April. A small infection center of cyst nematode occurred in the southwest corner of the field (buffer) but did not appear to influence performance within the tests. Although root symptoms were not obvious, after harvest was completed, soil samples from plot area suggested that BNYVV may have been present.

Bolting was very light. All tests had high stand counts and very few gaps or missing feet of row occurred.

All sugar samples were run through Holly's tare laboratory and Holly's plot harvesting equipment was used. We wish to acknowledge the help of Mary Pistole from Holly's tare laboratory and Dick Frey and Cliff Brown from the Irrigated Desert Research Station.

TEST B389. Means and ranges for S_1 progeny families from popn-790C4 at Brawley.

100 entries x 3 reps., RCB
1-row plots, 12 ft. long

Planted: Sept. 20, 1988
Harvd: May 23, 1989

Variable	Mean	Range	LSD (.05)	CV (%)
Sugar Yield/A	5,450	3,830 - 7,250	1,230	14.0
Root Yield/A	22.1	14.7 - 32.0	4.3	12.2
% Sucrose	12.4	9.7 - 14.1	1.3	6.5
PPM Na	620	285 - 1,160	369	37.0
PPM K	2,490	1,502 - 4,096	998	29.9
PPM NH_2-N	702	382 - 1,191	334	29.6
Impurity value	15,050	9,580 - 22,830	5,800	23.9
Impurity index	1,240	726 - 2,237	525	26.3
KSL/A	994	479 - 1,609	453	28.3
Rec. sugar/A	4,460	2,780 - 6,210	1,120	15.6
Rec. Sug/T	202	135 - 244	33	10.1
% Rec. sugar	81.4	66.4 - 89.1	7.9	6.0
Bolters (%)	0.14	0.0 - 8.8	1.2	524.0
Beets/100ft.	151	91 - 194	33	13.6
% clean beets	90.4	81 - 95	3	2.1
Nitrate - N	4.2	2.3 - 5.7	1.0	14.4

S_1 progenies were tested per se. The very high dispersion of the means suggested considerable variability for reaction to LIYV within popn-790C4. S_1 families with apparent superiority for resistance (sugar yield & quality) will be increased and tested as components of experimental hybrids.

TEST B589. EVALUATION OF HYBRID PERFORMANCE OF GERMPLASM LINES, BRAWLEY, CA., 1988-89

16 entries x 8 reps, RCB
1-row plots, 24 ft. long

Planted: September 20, 1988
Harvested: May 18, 1989

Variety	Description[1]	Acre Yield Sugar lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
HH 41	41318, Holly	8,360	33.53	12.52	193	89.4	4.5
Y846H23	87-309H37 x Y746	7,906	31.46	12.60	175	89.2	4.4
R847H68	7767HO x R747	7,669	30.95	12.40	176	90.4	4.6
7903H82	C310aa x 6903	7,394	28.13	13.12	180	88.8	4.0
Y846H33	7790Daa(C1) x Y746	7,080	28.75	12.33	166	87.5	4.4
Y731H67	6767aa x F86-31/6	7,067	27.62	12.77	173	88.1	4.1
Y846H68	7767HO x Y746	6,949	29.00	11.98	186	86.8	4.8
Y846H34	7790Faa(C2) x Y746	6,915	29.03	11.86	167	87.7	4.9
Y846H36	7790Laa(C4) x Y746	6,901	28.39	12.17	168	88.0	4.5
Y846H35	6790Kaa(C3) x Y746	6,828	27.97	12.21	162	87.4	4.5
Y854H68	7767HO x Y654	6,596	27.76	11.87	167	89.6	4.8
R873H68	7767HO x R773	6,581	28.92	11.36	180	87.5	4.8
8909H68	7767HO x 7909	6,553	28.46	11.52	187	87.3	5.1
Y846H32	7790Caa(CO) x Y746	6,228	26.23	11.88	182	87.7	4.7
US H11	786442, C546H3 x C36	6,195	27.32	11.34	199	86.8	5.2
N801H20	87-309H3 c B883	6,179	29.72	10.42	190	93.2	5.6
MEAN		6,963	28.95	12.02	178	88.5	4.7
LSD (.05)		699.4	2.3	0.6	13.8	1.7	0.5
C.V. (%)		10.1	8.1	4.7	7.8	1.9	10.4
F value		6.2**	4.6**	10.6**	4.9**	7.4**	5.7**

Note: Severe LIYV infection.

[1] 7900-popns CO thru C4 with 0 to 4 cycles of S_1 progeny recurrent selections for yield at Salinas. B883 = Nema resistant line from I.R.S.

TEST B189. GCA OF MULTIGERM GERMPLASM AND ADVANCED BREEDING LINES, BRAWLEY, CA., 1988-89

20 entries x 10 reps, RCB
1-row plots, 40 ft. long

Planted: September 19, 1988
Harvested: May 22, 1989

Variety	Description[1]	Acre Yield[2]		Sucrose	Bolters	Beets/ 100'	Clean Beets
		Sugar Lbs	Beets Tons	%	%	No.	%
Y746H34	C313CMS x Y646 (C46/2)	7,201	29.61	12.08	0.0	178	90.9
Y746H51	6833aa x Y646	7,198	29.41	12.22	0.0	165	90.4
Y731H23	86-309H37 x F86-31/6	6,807	30.37	11.15	0.1	187	92.6
Y846H38	C312CMS x Y746 (C46/3)	6,727	30.06	11.11	0.0	177	91.7
R847H23	87-309H37 x R747 (C47R)	6,689	27.27	12.23	0.4	180	91.5
Y846H37	85-306CMS x Y746	6,644	30.23	10.96	0.0	180	89.3
8909H23	87-309H37 x 7909	6,486	28.22	11.39	0.1	180	88.7
R873H23	87-309H37 x R773	6,486	28.22	11.46	2.3	171	91.3
HH 41	41318	6,300	28.04	11.13	0.0	193	91.4
Y846H23	87-309H37 x Y746	6,282	27.90	11.27	0.0	178	89.8
Y846H39	C762-17HO x Y746	6,253	28.20	11.01	0.0	170	89.6
R839-6H23	87-309H37 x R739-6	6,093	26.28	11.58	0.5	181	89.7
Y846H26	87-309CMS x Y746	6,014	25.18	11.92	0.0	177	90.6
Y854H23	87-309H37 x Y654	5,888	26.57	11.01	0.2	170	91.2
R839H23	87-309H37 x R739(C3)	5,705	26.17	10.84	0.9	177	89.0
Y846H66	C766-23HO x Y746	5,576	24.87	11.17	0.0	173	90.3

TEST B189. GCA OF MULTIGERM GERMPLASM AND ADVANCED BREEDING LINES, BRAWLEY, CA., 1988-89
(continued)

Variety	Description[1]	Acre Yield[2] Sugar	Acre Yield[2] Beets	Sucrose	Bolters	Beets/ 100'	Clean Beets
		Lbs	Tons	%	%	No.	%
Y846H89	C790-68HO x Y746	5,549	24.21	11.39	0.1	165	88.6
Y846H70	C766-62HO x Y746	5,450	24.84	10.93	0.0	170	89.2
Y846H8	F82-546H3 x Y746	4,625	21.85	10.48	0.0	182	89.2
US H11	786442, C546H3 x C36	3,825	22.03	8.55	0.0	195	88.9
MEAN		6,090	26.98	11.19	0.2	177	90.2
LSD (.05)		516	1.79	0.68	0.7	15.5	1.5
C.V. (%)		8.6	6.7	6.2	282.9	8.8	1.7
F value		25.0**	19.8**	12.9**	6.2**	2.6**	5.9**

Note: Severe LIYV infection.

TEST B189. GCA OF MULTIGERM GERMPLASM AND ADVANCED BREEDING LINES, BRAWLEY, CA., 1988-89
(continued)

20 entries x 10 reps, RCB
1-row plots, 40 ft. long

Planted: September 19, 1988
Harvested: May 22, 1989

Variety	Brei NO_3-N[3] Rating	Na PPM	K PPM	NH_4-N PPM	Impur. Value[4]	Impur. Index	Recover. Sugar %	Recover. Sugar[4] Lbs/Ton
Y746H34	4.3	567	2,661	359	12,056	1,046	84.3	205
Y746H51	4.3	575	2,473	420	12,188	1,012	84.8	207
Y731H23	4.7	827	2,403	373	12,454	1,165	82.5	185
Y846H38	4.4	803	2,578	253	11,668	1,118	83.2	187
R847H23	4.5	579	1,876	349	10,045	840	87.3	214
Y846H37	4.9	644	2,274	322	11,001	1,028	84.5	186
8909H23	4.4	795	2,663	540	14,581	1,328	80.0	184
R873H23	4.7	735	2,577	539	14,146	1,255	81.1	186
HH 41	4.7	729	2,207	330	11,213	1,017	84.7	188
Y846H23	4.6	589	2,164	349	10,794	963	85.5	193
Y846H39	4.7	744	2,759	362	12,951	1,219	81.7	181
R839-6H23	4.9	704	2,698	659	15,478	1,355	79.6	185
Y846H26	4.4	727	2,363	418	12,426	1,064	84.0	201
Y854H23	4.8	775	2,498	398	12,751	1,193	82.1	181
R839H23	5.1	803	2,542	487	13,794	1,350	79.7	175
Y846H66	4.8	713	2,212	317	11,040	1,021	84.6	190

TEST B189. GCA OF MULTIGERM GERMPLASM AND ADVANCED BREEDING LINES, BRAWLEY, CA., 1988-89
(continued)

Variety	Brei NO_3-N[3] Rating	Na PPM	K PPM	NH_4-N PPM	Impur. Value[4]	Impur. Index	Recover. Sugar %	Recover. Sugar[4] Lbs/Ton
Y846H89	4.7	602	2,263	342	11,020	987	85.1	194
Y846H70	5.1	694	2,400	397	12,202	1,126	83.1	181
Y846H8	4.8	660	2,308	388	11,771	1,186	82.2	174
US H11	5.7	900	2,422	301	12,070	1,482	77.7	134
MEAN	4.7	708	2,417	395	12,282	1,138	82.9	187
LSD (.05)	0.5	203	506	149	2,688	265	4.0	15.0
C.V. (%)	10.8	29	21	38	22	24	4.8	8.1
F value	4.2**	2.1**	1.8*	4.1**	2.6**	3.6**	3.6**	11.3**

[1] Y646 (C46/3) = nonreleased reselection from C46/2. 309H37 = C306 x C309. 6833 = C303aa x C309.
[2] Yield adjusted to a clean weight basis. Tare = both soil and crown tare.
[3] NO_3-N values by Holly's scale where 1 = 1.8, 2 = 3.5, 3 = 6.9,..., 9 = 400 ppm NO_3-N in brei.
[4] Extractable sugar based upon impurity value where impurity value = 3.5 ppm Na + 2.5 ppm K + 9.5 ppm NH_4-N. Sugar loss per ton of beets = (Impurity value) (1.5) (0.002).

TEST B489. RETEST OF MONOGERM LINES WITH C46 TESTER, BRAWLEY, CA., 1988-89

32 entries x 8 reps, RCB
1-row plots, 24 ft. long

Planted: September 20, 1988
Harvested: May 18-19, 1989

Variety	Description[1]	Acre Yield		Sucrose	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Sugar Lbs	Beets Tons	%	No.	%	Rating
Y846H38	C312CMS x Y746	8,377	33.26	12.62	177	90.4	4.3
HH52	Holly	8,169	32.05	12.78	193	91.8	3.8
Y846H101	7851aa x Y746	8,041	30.56	13.15	169	89.9	3.8
Y846H105	7855aa x Y746	7,969	30.05	13.26	173	90.1	3.8
Y846H37	85-306CMS x Y746	7,964	32.75	12.23	177	90.0	4.3
Y846H23	87-309H37 x Y746	7,920	30.72	12.89	186	88.2	3.3
Y846H76	7776aa x Y746	7,903	29.72	13.29	176	88.6	3.7
HH41	41318, Holly	7,695	30.52	12.60	194	90.8	4.5
Y846H51	5767-27aa x Y746	7,667	28.42	13.40	179	89.7	4.3
Y846H63	7766-38HO x Y746	7,593	28.81	13.16	185	89.2	3.8
Y846H115	7226aa x Y746	7,566	29.13	13.01	173	88.9	4.0
Y846H82	C310aa x Y746	7,552	28.45	13.27	187	90.4	3.5
Y846H62	7766-14HO x Y746	7,551	30.15	12.52	164	91.9	4.1
Y846H26	87-309CMS x Y746	7,523	27.86	13.51	169	88.3	3.8
Y846H116	7228aa x Y746	7,308	27.24	13.47	180	88.9	3.5
Y846H64	7766-44HO x Y746	7,300	27.95	13.01	182	88.6	4.0
Y846H55	5767-47aa x Y746	7,244	29.38	12.31	185	88.5	4.6
Y846H61	7766-8HO x Y746	7,153	28.75	12.41	169	87.0	4.0
Y846H114	7224aa x Y746	7,134	28.49	12.54	178	89.3	4.2
Y846H66	C766-23HO x Y746	6,935	26.96	12.91	175	88.9	3.8

TEST B489. RETEST OF MONOGERM LINES WITH C46 TESTER, BRAWLEY, CA., 1988-89
(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
Y846H70	C766-62HO x Y746	6,772	26.81	12.54	178	88.3	4.6
Y846H99	6796-6HO x Y746	6,716	26.35	12.75	172	87.9	4.0
Y846H67	7767aa x Y746	6,669	27.05	12.33	175	87.3	4.6
Y846H97	C796-43HO x Y746	6,564	25.71	12.76	174	87.7	3.8
846H50	5767-20aa x Y746	6,509	24.90	13.05	184	88.5	4.0
Y846H8	F82-546H3 x Y746	6,341	25.84	12.35	192	89.9	4.1
Y846H54	5767-46aa x Y746	6,297	25.26	12.56	187	86.6	4.0
Y846H53	5767-44aa x Y746	6,278	25.59	12.30	179	86.0	4.0
Y846H94	6796-28HO x Y746	6,112	24.55	12.43	171	85.5	3.8
Y846H85	C790-92HO x Y746	6,089	26.25	11.56	176	86.9	4.6
Y846H52	5767-30aa x Y746	6,028	25.49	11.79	171	86.8	4.2
US H11	786442, C546H3 x C36	5,696	24.26	11.80	193	85.7	4.5
MEAN		7,145	28.10	12.71	179	88.6	4.0
LSD (.05)		775.4	2.43	0.9	14.8	2.5	0.7
C.V. (%)		11.0	8.80	6.8	8.4	2.8	16.7
F value		6.8**	7.6**	2.6**	2.2**	3.4**	2.0**

Note: Severe LIYV infection.

[1]HO = CMS; aa = genetic ms. Y746 = C46/3. 309H37 = C306 x C309. 7767, 7776, 7851, 7855, 7224, 7226, 7228 = mm,S^f,A:aa popns. 5767-# & 7766-# = S_1 lines extracted from popn-767.

TEST B289. AREA 5 CODED VARIETY TRIAL, BRAWLEY, CA., 1988-89

24 entries x 10 reps, RCB
1-row plots, 40 ft. long

Planted: September 19, 1988
Harvested: May 23-24, 1989

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/ 100' No.	Clean Beets %
5-89-4	87C40-09	Holly	7,492	30.46	12.33	0.0	142	92.7
5-89-22	87C40-011	Holly	7,412	30.68	12.05	0.0	174	92.8
5-89-3	87C40-010	Holly	7,359	29.04	12.65	0.0	160	92.5
5-89-19	87C40-07	Holly	7,305	31.40	11.64	0.0	150	92.7
5-89-15	87C40-08	Holly	7,283	30.58	11.89	0.0	145	92.8
5-89-21	86-84C80-019	Holly	7,143	28.00	12.74	1.1	187	93.5
5-89-10	86-1459-029	Holly	7,064	27.50	12.86	0.1	173	93.5
5-89-8	HH 41	Holly	7,012	29.03	12.05	0.2	188	93.5
5-89-5	HH 52	Holly	6,936	27.98	12.39	0.1	177	93.4
5-89-2	HH 51	Holly	6,860	29.45	11.62	0.1	186	92.9
5-89-12	87C40-012	Holly	6,818	27.94	12.23	0.0	172	93.2
5-89-17	86-84C26-08	Holly	6,687	25.49	13.08	0.1	170	94.0
5-89-11	6BG6165	Betaseed	6,602	26.06	12.68	0.0	163	90.7
5-89-18	84C39-033	Holly	6,490	27.04	11.99	0.3	163	92.8
5-89-14	HH 37	Holly	6,335	26.45	11.94	0.1	178	93.3
5-89-16	84C34-09	Holly	6,176	24.92	12.39	0.0	152	93.3
5-89-1	6BG6162	Betaseed	6,125	25.06	12.26	0.0	173	91.4
5-89-6	USC 4	Union	6,087	25.55	11.87	0.1	187	90.4
5-89-7	7BG6111	Betaseed	6,042	24.24	12.44	0.4	178	90.7
5-89-13	6BG6151	Betaseed	5,973	24.59	12.13	0.0	171	91.6

TEST B289. AREA 5 CODED VARIETY TRIAL, BRAWLEY, CA., 1988-89
(continued)

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/ 100' No.	Clean Beets %
5-89-9	H85364	Spreckels	5,927	26.47	11.13	0.0	179	91.9
5-89-20	SS NB3	Spreckels	5,882	25.49	11.49	0.0	184	91.9
5-89-23	HM6036	Mono-Hy	5,525	24.57	11.22	0.0	177	90.7
5-89-24	US H11	Check	4,734	22.48	10.51	0.1	185	89.3
MEAN			6,553	27.10	12.07	0.1	171	92.3
LSD (.05)			518	1.41	0.65	0.3	13	1.1
C.V. (%)			9	5.90	6.10	336.8	8.8	1.4
F value			13.8**	22.4**	6.5**	3.1**	8.0**	8.8**

Notes: Severe LIYV infection. Harvested wet (2 wks after irrigation) and under very high nitrogen status.

TEST B289. AREA CODED VARIETY TRIAL, BRAWLEY, CA., 1988-89
(continued)

24 entries x 10 reps, RCB
1-row plots, 40 ft. long

Planted: September 19, 1988
Harvested: May 23-24, 1989

Variety	Nitrate Nitrogen Rating	Sodium PPM	Potassium PPM	Amino Nitrogen PPM	Impur. Value[1]	Recover. Sugar[1] %	Recover. Sugar[1] Lbs/Ton
87C40-09	4.5	450	2,268	456	11,588	85.7	211
87C40-011	4.6	533	2,554	539	13,377	83.3	200
87C40-010	4.1	432	2,217	542	12,210	85.4	216
87C40-07	4.4	452	2,530	460	12,290	84.0	195
87C40-08	4.6	551	2,659	539	13,709	82.3	196
86-84C80-019	4.6	660	2,301	503	12,847	84.4	216
86-1459-029	4.4	565	2,077	446	11,416	86.5	222
HH 41	4.6	639	2,300	437	12,142	84.7	204
HH 52	4.3	519	2,487	474	12,541	84.6	210
HH 51	4.9	581	2,323	431	11,944	84.4	196
87C40-012	4.4	470	2,345	537	12,614	84.3	206
86-84C26-08	4.4	577	2,200	497	12,246	85.8	224
6BG6165	4.3	560	2,545	495	13,034	84.2	214
84C39-033	4.7	718	2,285	470	12,701	83.8	201
HH 37	4.8	603	2,011	428	11,208	85.8	205
84C34-09	4.2	517	2,311	449	11,863	85.3	212

TEST B289. AREA CODED VARIETY TRIAL, BRAWLEY, CA., 1988-89
(continued)

Variety	Nitrate Nitrogen Rating	Sodium PPM	Potassium PPM	Amino Nitrogen PPM	Impur. Value[1]	Recover. Sugar[1] %	Recover. Sugar[1] Lbs/Ton
6BG6162	4.5	595	2,436	528	13,196	83.3	205
USC 4	4.7	579	2,411	433	12,179	84.3	200
7BG6111	4.3	602	2,350	459	12,351	85.0	211
6BG6151	4.4	561	2,517	569	13,669	83.0	201
H85364	4.7	934	2,466	333	12,603	82.2	184
SS NB3	4.7	582	2,209	429	11,639	84.2	194
HM6036	4.7	691	2,904	560	15,002	79.3	179
US H11	5.1	688	2,697	482	13,736	79.7	169
MEAN	4.5	586	2,392	479	12,588	84.0	203
LSD (.05)	0.3	139	380	125	NS	3.1	15
C.V. (%)	8.9	27.0	18.1	29.7	19.8	4.2	8.5
F value	3.4**	4.5**	2.2**	1.5NS	1.2NS	2.4**	5.7**

[1]Impurity value = 3.5 ppm Na + 2.5 ppm K + 9.5 ppm NH_4-N.
Sugar loss per ton of beets = (Impurity value)(1.5)(0.002)

TEST 189. BOLTING EVALUATION AND OBSERVATION TEST
OF LINES AND S_1's FROM BBcms x LINES, SALINAS, CA., 1989

80 entries x 3 replications Planted: November 28, 1989
1-row plots, 16 ft. long

Variety	Description	Stand[1] Count	Bolting 6/2	Bolting 6/20	Bolting 7/6	Bolting 9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
Checks							
4500	Inc. 1500	63	100.0	100.0	100.0	100.0	--
4500HO	1500HO x 1500	62	100.0	100.0	100.0	100.0	--
6600	Inc. 4600	72	97.2	100.0	100.0	100.0	--
6600HO	5216CMS x 4600	49	89.8	100.0	100.0	100.0	--
81-37	81101, C37	67	0.0	0.0	0.0	3.0	3.4
SP6822-0	L80466 (8/87)	72	29.2	63.9	83.3	90.3	3.0
Y846	Inc. Y746	49	0.0	0.0	0.0	0.0	2.2
EL42		0	--	--	--	--	--
FC 709	811056H	67	10.4	26.9	34.3	41.8	3.3
Y009	Inc. US22/3	76	36.8	46.1	63.2	73.7	3.9
82-546H3	82460	66	0.0	0.0	3.0	12.1	3.6
82-562	82196	70	0.0	7.1	12.9	15.7	3.6
F82-562HO	82195	68	0.0	4.4	20.6	30.9	3.3
87-309	C309	78	0.0	2.6	2.6	5.1	4.1
87-309CMS	C309CMS	71	1.4	5.6	9.9	12.7	4.0
F85-796-22CMS	85063,C796-22CMS	65	0.0	0.0	1.5	3.1	2.5
87-309H3	C562HO x C309	67	0.0	0.0	7.5	14.9	3.4
5816H92	C796-22HO x C309	72	0.0	0.0	1.4	4.2	3.7
85-796-22H3	85522	70	0.0	0.0	1.4	7.1	2.7
5816-2	Inc.4755-46-2(A)	70	0.0	0.0	0.0	0.0	1.5
5816-9	Inc.4755-46-2(A)	71	0.0	1.4	1.4	2.8	2.8
5816-21	Inc.4755-46-21(A)	77	0.0	0.0	0.0	1.3	3.5
5816-24	Inc.755-46-24(A)	79	0.0	1.3	1.3	1.3	2.7
86-309	86706 (Clark)	79	0.0	1.3	5.1	8.9	4.4
S_1's of inbred lines							
7268-1	F82-562	20	0.0	0.0	0.0	0.0	0.1
-2		75	0.0	0.0	0.0	2.7	4.8
-3		41	0.0	0.0	0.0	2.4	0.6
-4		42	0.0	0.0	0.0	2.4	0.0
7269-1	0502 (NB1)	51	0.0	0.0	2.0	3.9	3.1
-2		61	0.0	0.0	0.0	6.6	3.5
-3		55	0.0	0.0	0.0	3.6	3.5
-4		44	0.0	0.0	0.0	0.0	3.0

TEST 189. BOLTING EVALUATION AND OBSERVATION TEST OF LINES AND S_1'S FROM BBcms x LINES, SALINAS, CA., 1989

(continued)

Variety	Description	Stand[1] Count	Bolting 6/2	Bolting 6/20	Bolting 7/6	Bolting 9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
7270-1	1512 (NB6)	63	0.0	0.0	0.0	0.0	2.3
-2		58	0.0	0.0	0.0	0.0	2.9
-3		48	0.0	0.0	0.0	0.0	2.9
-4		35	0.0	0.0	0.0	0.0	2.7
7271-1	1547 (NB5)	54	0.0	0.0	0.0	0.0	0.6
-2		73	0.0	0.0	0.0	0.0	0.7
-3		58	0.0	0.0	0.0	0.0	0.4
-4		62	0.0	0.0	0.0	0.0	0.5
7272-1	0554 (NB4)	33	0.0	0.0	0.0	0.0	0.1
-2		52	0.0	0.0	0.0	0.0	0.1
-3		58	0.0	0.0	0.0	0.0	0.2
-4		55	0.0	0.0	0.0	0.0	0.0
7273-1	85-796-22	36	0.0	0.0	0.0	0.0	3.2
-2		33	0.0	0.0	0.0	0.0	1.5
-3		47	0.0	0.0	0.0	0.0	2.3
-4		58	0.0	0.0	0.0	0.0	2.2
7273-6		31	0.0	0.0	0.0	3.2	2.0
7274-1	86-309	49	0.0	2.0	2.0	10.2	4.1
-2		63	0.0	0.0	6.3	14.3	4.5
-3		57	0.0	0.0	0.0	1.8	3.0
-4		73	0.0	0.0	2.7	11.0	3.9
-5		75	0.0	0.0	1.3	4.0	2.9
-6		68	0.0	0.0	5.9	11.8	3.0
-7		49	10.2	36.7	57.1	71.4	6.7
7274-8		63	0.0	0.0	3.2	9.5	3.6
7275-1	5816-2 (C309)	51	0.0	0.0	0.0	0.0	0.8
-2		60	0.0	0.0	1.7	1.7	1.3
-3		64	0.0	0.0	0.0	0.0	1.3
-4		68	0.0	0.0	0.0	1.5	2.2
7276-1	5816-9	65	0.0	0.0	0.0	1.5	2.8
-2		73	0.0	0.0	0.0	0.0	2.6
-3		73	0.0	0.0	0.0	0.0	2.6
-4		60	0.0	0.0	0.0	0.0	3.3
7277-1	5816-21	23	0.0	0.0	0.0	0.0	3.0
-3		51	0.0	2.0	3.9	3.9	3.4
-4		51	0.0	0.0	0.0	0.0	3.3

TEST 189. BOLTING EVALUATION AND OBSERVATION TEST OF LINES AND S_1'S FROM BBcms x LINES, SALINAS, CA., 1989

(continued)

Variety	Description	Stand[1] Count	Bolting 6/2	Bolting 6/20	Bolting 7/6	Bolting 9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
7277-5		50	0.0	0.0	6.0	16.0	4.6
7278-1	5816-24	49	0.0	0.0	4.1	4.1	3.9
-4		72	0.0	0.0	1.4	5.6	2.9
-5		63	0.0	0.0	0.0	0.0	3.9
Checks							
4600	Inc. 8600	73	100.0	100.0	100.0	100.0	--
6600	Inc. 4600	71	100.0	100.0	100.0	100.0	--
7600(B)	Inc. 4600	72	100.0	100.0	100.0	100.0	--
8600(B)	Inc. 7600(B)	72	100.0	100.0	100.0	100.0	--
86-37	86443, C37	72	0.0	0.0	0.0	0.0	3.0
SP6822-0	L80466(8/87)	68	38.2	80.9	89.7	91.2	2.4
F82-562	82196	72	0.0	4.2	15.3	23.6	3.8
8502	Inc. 1502(NB1)	69	0.0	2.9	14.5	31.9	4.2

This test corresponds to 1988 tests for NB in the field (SP 2688) and greenhouse. Determine if bolting tendency of S_1 families (bb) corresponds to bolting of TX (Bb) families. Can BBcms be used as a tester to identify and screen NB tendency of bb genotypes?

[1]Total number plants in 3 replications.

[2]Powdery mildew rated 0 to 9 where 0 = no evidence of disease. Average of ratings made on 7/19, 7/27, 8/9, 8/16, and 8/23/89.

TEST 289. BOLTING EVALUATION AND OBSERVATION TEST OF LINES AND S_1'S FROM BBcms x 7852 & 7855, SALINAS, CA., 1988-89

160 entries x 3 replications — Planted: November 28, 1988
1-row plots, 16 ft. long

Variety	Description	Stand[1] Coun	Bolting 6/2	6/21	7/6	9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
Checks							
4500	Inc. 1500 (Owen's T-O)	64	96.9	100.0	100.0	100.0	--
4500HO	1500HO x 1500	78	100.0	100.0	100.0	100.0	--
7600(A)	Inc. 4600	69	98.6	98.6	100.0	100.0	--
7600HO(A)	6271-2CMS x 4600	66	96.9	98.6	100.0	100.0	--
7600(B)	Inc. 4600	74	98.6	98.6	100.0	100.0	--
7600HO(B	6271-3CMS x 4600	62	85.5	100.0	100.0	100.0	--
8600(A)	Inc. 4600(B)	62	100.0	100.0	100.0	100.0	--
8600HO(A	7600HO(A) x 4600(B)	61	93.4	98.4	100.0	100.0	--
8600(B)	Inc. 7600(B)	62	100.0	100.0	100.0	100.0	--
8600HO(B	7600HO(B) x 4600(B)	64	93.8	100.0	100.0	100.0	--
7852	RZM 6224(A,aa)	81	0.0	0.1	2.5	8.6	4.3
8852	RZM 7852(A,aa)	67	0.0	1.5	2.9	2.9	3.2
7855	RZM 6222,3(A,aa)	76	2.6	7.9	14.5	18.4	3.3
8855	RZM 7855(A,aa)	70	0.0	4.3	12.9	11.4	2.6
86-37	86443, C37	75	0.0	0.0	0.0	0.0	2.7
SP6822-0	L80466(8/87)	78	34.6	60.3	74.4	82.1	2.1
8852 - S_1's							
8852-1	7852-1	39	0.0	0.0	5.1	7.6	3.5
-2	-2	72	0.0	2.8	5.6	8.3	3.2
-3	-3	51	0.0	1.9	3.9	5.9	2.9
-4	-4	60	1.7	6.7	15.0	31.7	3.9
-5	-5	62	0.0	0.0	4.8	11.3	3.4
-6	-6	60	0.0	1.7	1.7	6.7	4.5
-7	-7	68	0.0	0.0	0.0	0.0	3.5
-8	-8	55	7.3	10.9	23.6	29.1	4.3
-9	-9	52	0.0	0.0	0.0	3.8	4.2
-10	-10	54	3.7	7.4	11.1	20.3	6.4
-11	-11	55	0.0	0.0	3.6	5.5	1.3
-12	-12	66	0.0	1.5	7.6	13.6	4.2
-13	-13	56	3.6	14.3	21.4	28.6	3.5
-14	-14	56	0.0	0.0	0.0	0.0	4.7
-15	-15	42	0.0	0.0	0.0	0.0	8.3
-16	-16	32	0.0	3.3	9.4	15.6	4.9

TEST 289. BOLTING EVALUATION AND OBSERVATION TEST OF LINES AND S_1'S FROM BBcms x 7852 & 7855, SALINAS, CA., 1988-89

(continued)

Variety	Description	Stand[1] Count	Bolting 6/2	Bolting 6/21	Bolting 7/6	Bolting 9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
8852-17	7852-17	60	0.0	0.0	1.7	1.7	2.9
-18	-18	69	0.0	0.0	1.4	7.2	4.7
-19	-19	53	0.0	0.0	0.0	0.0	4.8
-20	-20	73	0.0	0.0	0.0	0.0	4.9
-21	-21	59	0.0	3.4	5.1	15.3	6.1
-22	-22	55	0.0	3.6	3.6	10.9	3.8
-23	-23	47	0.0	19.1	27.7	40.4	5.9
-24	-24	44	2.3	2.3	2.3	6.8	4.9
-25	-25	45	0.0	0.0	6.7	13.3	7.0
-26	-26	24	0.0	0.0	4.2	8.3	5.5
-27	-27	48	2.1	18.8	31.3	47.9	5.1
-28	-28	50	0.0	2.0	14.0	22.0	4.3
-29	-29	41	0.0	2.4	2.4	4.9	2.9
-30	-30	53	0.0	5.7	13.2	16.9	4.4
-31	-31	47	0.0	0.0	8.5	25.5	4.1
-32	-32	58	0.0	6.9	17.2	22.4	3.6
8852-33	7852-33	54	0.0	0.0	0.0	1.9	1.1
-34	-34	54	0.0	0.0	0.0	3.7	3.9
-35	-35	53	0.0	0.0	5.7	16.9	3.3
-36	-36	56	7.1	25.0	41.1	44.6	3.0
-38	-38	56	0.0	0.0	7.1	14.3	2.0
-39	-39	52	0.0	3.8	7.7	23.1	3.7
-40	-40	52	0.0	3.8	5.8	17.3	2.6
-41	-41	50	0.0	0.0	0.0	0.0	3.1
-42	-42	48	0.0	0.0	0.0	0.0	3.8
-43	-43	54	1.9	1.9	7.4	11.1	3.0
-44	-44	73	0.0	0.0	0.0	1.4	4.8
-45	-45	66	0.0	0.0	0.0	0.0	4.5
-46	-46	54	0.0	0.0	11.1	22.2	3.6
-47	-47	49	6.1	6.1	14.3	26.5	2.1
-48	-48	56	0.0	1.8	3.6	5.4	4.7
-49	-49	69	0.0	0.0	2.9	15.9	3.7
8852-50	-50	56	5.4	12.5	21.4	42.9	1.9
-51	-51	61	0.0	11.5	21.3	26.2	6.3
-52	-52	70	0.0	0.0	0.0	0.0	2.7
-53	-53	65	1.5	1.5	9.2	12.3	3.6

TEST 289. BOLTING EVALUATION AND OBSERVATION TEST OF LINES AND S_1'S FROM BBcms x 7852 & 7855, SALINAS, CA., 1988-89

(continued)

Variety	Description	Stand[1] Count	Bolting 6/2	6/21	7/6	9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
8852-54	7852-54	66	0.0	0.0	0.0	1.5	4.4
-55	-55	31	3.2	3.2	9.7	12.9	3.3
-56	-56	65	0.0	1.5	3.1	7.6	3.7
-57	-57	51	0.0	0.0	1.9	7.8	6.7
-58	-58	46	0.0	2.2	8.7	21.7	2.2
-59	-59	46	0.0	0.0	2.2	10.9	2.3
-60	-60	39	0.0	2.6	7.7	15.4	3.7
-61	-61	54	3.7	9.3	29.6	37.0	4.1
-62	-62	33	0.0	3.0	6.0	21.2	2.1
-63	-63	58	0.0	3.4	12.1	12.1	6.6
-64	-64	45	0.0	2.2	2.2	11.1	1.5
-65	-65	24	0.0	12.5	16.7	16.7	3.4
8852-66	7852-66	47	0.0	0.0	0.0	2.1	3.8
-67	-67	47	0.0	0.0	2.1	6.4	3.8
-68	-68	68	0.0	2.9	2.9	8.8	3.7
-69	-69	62	0.0	1.6	4.8	9.7	4.9
-70	-70	44	2.3	9.1	22.7	22.7	4.6
-71	-71	62	0.0	0.0	0.0	0.0	3.8
-72	-72	46	0.0	0.0	4.3	17.4	2.5
-73	-73	52	0.0	5.8	17.3	28.8	3.1
8855-S_1's							
8855-2	7855-2	62	0.0	0.0	1.6	1.6	2.4
-3	-3	43	13.9	30.2	46.5	62.8	5.2
-4	-4	52	0.0	0.0	3.8	13.5	4.5
-5	-5	59	0.0	1.7	8.5	20.3	2.0
8855-6	7855-6	72	0.0	0.0	1.4	1.4	6.0
-7	-7	72	4.2	4.2	11.1	15.3	3.3
-8	-8	49	0.0	2.0	16.3	20.4	1.9
-9	-9	68	0.0	0.0	0.0	2.9	1.6
8855-10	7855-10	62	1.6	30.6	58.1	70.9	5.9
-11	-11	74	0.0	0.0	1.4	5.4	4.1
-12	-12	52	15.4	26.9	51.9	61.5	7.3
-13	-13	60	15.0	13.3	16.7	15.0	2.2
-14	-14	58	3.4	12.1	25.9	36.2	2.9
-15	-15	40	0.0	0.0	2.5	2.5	2.6
-16	-16	62	6.5	9.6	14.5	24.2	3.5
-17	-17	68	0.0	1.5	1.5	2.9	4.9

TEST 289. BOLTING EVALUATION AND OBSERVATION TEST OF LINES AND S_1'S FROM BBcms x 7852 & 7855, SALINAS, CA., 1988-89

(continued)

Variety	Description	Stand[1] Count	Bolting 6/2	6/21	7/6	9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
8855-18	7855-18	75	0.0	1.3	2.7	12.0	4.4
-19	-19	65	0.0	1.5	3.1	6.2	3.8
-20	-20	73	4.1	24.6	52.1	83.6	3.2
-21	-21	67	0.0	0.0	0.0	1.5	4.7
-22	-22	75	0.0	0.0	0.0	0.0	3.7
-23	-23	50	0.0	6.0	12.0	18.0	4.0
-24	-24	47	0.0	0.0	0.0	0.0	1.9
-25	-25	54	0.0	3.7	11.1	25.9	4.6
8855-26	7855-26	54	3.7	33.3	37.0	44.4	4.9
-27	-27	59	0.0	0.0	1.7	5.1	4.1
-28	-28	67	1.5	7.5	14.9	14.9	3.6
-29	-29	61	0.0	18.0	49.2	91.0	5.1
8855-30	7855-30	73	0.0	4.1	12.3	28.8	6.7
-31	-31	58	1.7	5.2	17.2	25.8	2.3
-32	-32	67	0.0	0.0	0.0	0.0	4.1
-33	-33	73	4.1	10.9	16.4	23.3	1.9
-34	-34	68	0.0	0.0	1.5	4.4	2.7
-35	-35	76	0.0	7.8	17.1	22.4	4.5
-36	-36	74	0.0	0.0	0.0	0.0	4.9
-37	-37	59	0.0	25.4	44.1	55.9	6.2
-38	-38	72	0.0	0.0	0.0	2.8	4.1
-39	-39	79	6.3	12.7	29.1	39.2	3.9
-40	-40	51	3.9	4.9	19.6	21.6	3.2
-41	-41	66	7.6	16.7	37.9	54.5	5.9
8855-42	7855-42	69	24.6	42.0	57.9	66.7	4.3
-43	-43	68	0.0	2.9	3.6	7.4	5.2
-44	-44	73	5.5	10.9	24.7	31.5	6.7
-45	-45	69	0.0	0.0	5.8	10.1	5.3
-46	-46	73	0.0	1.4	2.7	5.5	2.5
-47	-47	44	2.3	20.0	22.7	34.1	3.9
-48	-48	69	0.0	0.0	0.0	2.9	4.3
-49	-49	70	1.4	5.7	24.3	38.6	5.5
-50	-50	71	0.0	2.8	2.8	4.2	4.1
-51	-51	76	0.0	1.3	2.6	3.9	2.2
-52	-52	62	0.0	0.0	1.6	1.6	4.7
-53	-53	61	0.0	0.0	0.0	3.3	2.4

TEST 289. BOLTING EVALUATION AND OBSERVATION TEST OF LINES AND S_1'S FROM BBcms x 7852 & 7855, SALINAS, CA., 1988-89

(continued)

Variety	Description	Stand[1] Count	Bolting 6/2	6/21	7/6	9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
8855-54	7855-54	66	30.3	35.7	37.9	39.4	3.1
-55	-55	64	0.0	0.0	0.0	0.0	3.5
-56	-56	56	0.0	0.0	0.0	3.6	3.3
-57	-57	70	1.4	17.1	22.9	21.4	3.9
8855-58	7855-58	74	0.0	0.0	0.0	1.4	4.5
-59	-59	31	0.0	0.0	3.2	6.5	4.3
-60	-60	72	0.0	0.0	2.8	11.1	6.9
-61	-61	58	0.0	0.0	0.0	0.0	4.9
-62	-62	69	5.8	27.5	60.9	63.8	7.4
-63	-63	64	0.0	0.0	0.0	0.0	3.5
-64	-64	53	1.9	9.4	15.1	18.9	4.7
Checks							
Y009	Inc. US 22/3	72	54.2	59.7	65.3	81.9	4.3
81-37	81101, C37	81	0.0	0.0	0.0	0.0	3.9
SP6822-0	L80466 (8/87)	80	31.3	45.0	51.3	58.8	3.6
FC709	Ft. Collins	68	23.5	54.0	61.8	75.0	3.5
F82-562	82196	76	0.0	6.6	18.4	31.6	3.6
0502	Inc.9502-3($S_{25}$of NB1)	62	0.0	0.0	0.0	3.2	3.7
1512	Inc. 6512 (NB6)	69	0.0	0.0	0.0	0.0	3.1
1547	Inc.0547($S_{19}$of NB 5)	70	0.0	0.0	0.0	0.0	0.8
0554	Inc.9554-1($S_{16}$of NB 4)	65	0.0	0.0	0.0	0.0	0.3

In gh 11, plants of 7852 and 7855 were selfed to produce S_1's and crossed to C600CMS. Corresponding S_1 and testcross families were produced. The S_1's are being evaluated in an overwintered test to evaluate bolting tendency. The Bb testcrosses were evaluated in greenhouse and field tests under long day conditions but without vernalization. Determine the correlation in bolting tendency between the corresponding Bb and bb families. The S_1's in Medford steck plot will be selected on basis of easy & hard bolting to produce new C1 synthetics & elite S_2's.

[1]Total number plants in 3 replications.

[2]Powdery mildew rated 0 to 9 where 0 = no evidence of disease. Average of ratings made on 7/19, 7/27, 8/9, 8/16, and 8/23/89.

TEST 389. BOLTING EVALUATION AND OBSERVATION TEST OF LINES
SALINAS, CA., 1988-89

160 entries x 3 replications — Planted: November 29, 1988
1-row plots, 16 ft. long

Variety	Description	Stand[1] Count	Bolting 6/2	Bolting 6/21	Bolting 7/6	Bolting 9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
Multigerm, O.P.							
86-37	86443, C37	78	0.0	0.0	0.0	2.6	3.5
R874	RZM R774	81	0.0	3.7	3.8	6.2	3.7
R879	RZM 7263	78	1.3	2.6	11.2	23.1	2.9
768	Inc. US75	75	0.0	0.0	2.6	5.3	4.4
F82-36	82421, C36	76	0.0	0.0	0.0	3.9	4.3
Y009	Inc. US 22/3	68	45.6	47.1	75.0	75.0	5.8
964	Inc. C64	78	0.0	0.0	0.0	1.3	4.3
Y748(C93)	YR-ER-PMR Y548	73	2.7	2.7	6.8	9.6	3.2
R818	RZM R718 (Y54 x Bm)	75	26.7	29.3	38.7	46.7	3.1
R821(C48)	RZM R721 (C37 x Bm)	77	7.8	19.5	24.7	44.2	4.1
R824	RZM 7241 (C37 x Bm)	82	1.3	2.4	3.7	11.0	3.1
R825	RZM 7243 (C37 x Bm)	63	0.0	7.9	12.7	27.0	2.8
R826	RZM 7248 (C37 x Bm)	64	0.0	4.7	6.3	10.9	2.1
R827	RZM 7250 (Bm x C37)	83	0.0	2.4	3.6	9.6	3.0
R722(C50)	Inc. F_1&F_2(SBxBm)	76	34.2	50.0	59.2	72.4	3.1
86-46/2	86342, C46/2	80	0.0	0.0	0.0	1.3	2.3
Y846	Inc. Y746 (C46/3)	69	0.0	0.0	0.0	0.0	1.6
Y846(Aa)	Y746aa x A	81	0.0	0.0	0.0	1.2	1.3
Y846	YR-ER-PMR Y646 (C46/4)	71	0.0	0.0	0.0	0.0	1.5
R873	Inc. R773	76	1.3	2.6	5.3	7.9	1.7
R873	RZM R773	74	1.4	1.4	1.4	5.4	1.9
R878	RZM 7261	76	0.0	0.0	0.0	7.9	2.0
F86-31/6	86263, C31/6	74	0.0	0.0	0.0	1.4	1.5
Y731	YR-ER-PMR Y531 (C31/7)	71	0.0	0.0	0.0	1.4	1.3
R871	RZM R771	71	1.4	2.8	7.0	19.7	3.5
R876	RZM 7259	74	0.0	2.7	5.4	5.4	3.3
F86-92	86165, C92	77	1.3	2.6	7.8	26.0	2.2
Y752	NB Y552	76	0.0	0.0	0.0	7.9	1.5
R872	RZM R772	70	7.1	11.4	18.6	32.9	3.3
R877	RZM 7257	68	0.0	1.5	8.8	23.5	2.3
R847(C47R)	RZM R747	69	0.0	1.4	7.2	27.5	2.9
R847	Inc. R747	67	0.0	3.0	16.4	35.8	3.7

TEST 389. BOLTING EVALUATION AND OBSERVATION TEST OF LINES
SALINAS, CA., 1988-89

(continued)

Variety	Description	Stand[1] Count	Bolting 6/2	6/21	7/6	9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
Y747(C47)	YR-ER-PMR Y547	76	0.0	0.0	1.3	11.8	2.3
86-91	86019, C91	81	0.0	0.0	0.0	3.7	1.3
Y741	YR-ER-PMR Y541 (C91)	79	0.0	0.0	0.0	10.1	1.1
Y754	Inc. Y654	78	0.0	0.0	1.3	5.1	1.5
Y854	Inc. Y654	79	0.0	0.0	0.0	2.5	1.9
Y854(C54)	YR-ER-PMR Y654	85	0.0	1.2	1.2	2.4	1.8
R875	RZM 7258	84	0.0	3.6	7.1	7.1	2.7
Y853	YR-ER-PMR Y653	72	0.0	0.0	0.0	4.2	1.4
Y857	YR-ER-PMR Y657	70	0.0	0.0	0.0	0.0	3.9
R803	RZM R703 (Alba)	74	4.1	14.9	24.3	45.9	4.9
R813	RZM R713	81	0.0	1.2	4.9	22.2	3.1
R820(C94)	RZM R720	77	9.1	11.7	18.2	24.7	3.3
8101(C11T)	YR-ER-PMR 6101	74	0.0	0.0	2.7	4.1	3.1
8102(C12T)	YR-ER-PMR 6102	71	0.0	0.0	2.8	5.6	1.7
Y749(C49)	Inc. Y649	67	0.0	1.5	7.5	22.4	2.1
Y849	YR-ER-PMR Y649 (C49)	71	1.4	1.4	2.8	8.5	2.3
Y639(C39)	Inc. Y539	72	1.4	2.8	2.8	16.7	2.7
R839	Inc. R739(C3)	68	4.4	7.4	8.8	25.0	2.1
R839(C4)	RZM R739(C3), (C39/R4)	67	0.0	3.0	7.5	20.9	1.8
R839	RZM R739(CFS)	66	1.5	1.5	6.1	28.8	1.5
R839-4	RZM R739-4	73	0.0	0.0	1.4	28.8	2.2
R839-7	RZM R739-7	68	0.0	1.5	8.8	17.6	1.8
R839-6	RZM R739-6 (C39/R4-6)	69	0.0	0.0	2.9	4.3	1.4
R839-6	Inc. R739-6	64	0.0	0.0	0.0	0.0	1.5
Multigerm, S^f, A:aa							
5747	4747aa x A	70	0.0	0.0	1.4	5.7	3.1
7903	6903aa x A	69	0.0	0.0	0.0	4.3	2.3
8904	YR-ER-PMR 6904(A,aa)	67	0.0	0.0	1.5	6.0	1.9
5905	4905aa x A	66	0.0	0.0	3.3	4.5	2.4
7906B	6235aa x A	75	1.3	6.7	10.7	30.7	3.1
7906C	6236aa x A	76	0.0	3.9	7.9	22.4	2.1
7906D	6237aa x A	73	0.0	1.4	5.5	11.0	2.5
8906mm	RZM 7906,7mm	66	0.0	4.5	12.1	33.3	2.7

TEST 389. BOLTING EVALUATION AND OBSERVATION TEST OF LINES
SALINAS, CA., 1988-89

(continued)

Variety	Description	Stand[1] Count	Bolting 6/2	6/21	7/6	9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
8906	RZM 7906, 7aa x A	69	1.4	5.8	13.0	21.7	2.7
8906A	RZM 7906, 7(A)	74	1.4	1.4	4.1	16.2	2.4
8908	RZM 7908	71	0.0	2.8	2.8	7.0	2.4
8909	RZM 7909	66	0.0	1.5	10.6	13.6	2.1
8909	7909, 7239 aa x A	69	0.0	0.0	1.4	2.9	1.9
7909	RZM 6237	76	0.0	0.0	1.3	7.9	2.5
8910	RZM 7238	70	0.0	0.0	1.4	7.1	2.7
8911	RZM 7239	72	0.0	0.0	0.0	1.4	2.1
monogerm, S^f, A:aa							
8902	6902, 7902 selfed	62	0.0	0.0	0.0	4.8	2.1
8722	6722 selfed	72	0.0	0.0	0.0	0.0	2.8
8743(C798/2)	7743aa x A	82	0.0	2.4	3.7	8.5	2.9
5755(C310/5)	4755aa x A	83	1.2	3.6	5.8	15.7	3.4
6756(C310/6)	5756aa x A	88	0.0	1.1	2.3	4.5	2.7
8755(C310)	7755,6aa x A	82	0.0	0.0	1.2	2.4	3.2
8755HO	6756HO x 7755,6	80	0.0	0.0	2.5	3.8	2.5
8787	7755-7797aa x A	80	0.0	3.8	3.8	10.0	3.5
7767	6767aa x A	80	8.8	28.8	28.8	41.3	3.1
8767	NB 6767(A,aa)	80	0.0	1.3	1.3	6.3	2.3
7776	6776aa x A	82	1.2	2.4	7.3	18.3	3.0
8776	NB 6776(A,aa)	74	0.0	0.0	0.0	2.7	2.8
7790L(C790)	5790-#'s aa x A	78	0.0	1.3	6.4	15.4	2.8
8790	7790aa x A (C4,Syn2)	84	0.0	0.0	0.0	1.2	2.5
8790HO	7790HO x 7790	80	0.0	0.0	1.3	3.8	3.1
7797	YR-ER-PMR 5797(A,aa)	77	0.0	1.3	6.5	7.8	3.7
8796(C796)	7796aa x A	79	0.0	0.0	1.3	12.7	2.9
8796HO	5796HO x 7796	80	0.0	1.3	1.3	8.8	4.0
8850	RZM 7850	70	1.4	2.9	12.9	20.0	6.0
8850HO	7850HO x RZM 7850	72	0.0	11.1	23.6	26.4	4.9
8851	RZM 7851	77	0.0	0.0	2.6	5.2	3.7
8852	RZM 7852	74	0.0	0.0	2.7	6.8	3.7
8852HO	7852HO x RZM 7852	73	0.0	4.1	10.9	20.5	5.0
8853	RZM 7853	71	1.4	4.2	5.6	18.3	4.3

TEST 389. BOLTING EVALUATION AND OBSERVATION TEST OF LINES
SALINAS, CA., 1988-89

(continued)

Variety	Description	Stand[1] Count	Bolting 6/2	6/21	7/6	9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
8854	RZM 7854	70	0.0	1.4	5.7	5.7	4.5
8855	RZM 7855	78	0.0	2.6	6.4	10.3	2.6
8856	RZM 7228	81	0.0	0.0	1.2	2.5	2.5
8857	RZM 7224,5	72	0.0	2.8	5.6	16.7	3.9
8857HO	7852HO x RM 7224, 5	74	4.1	5.4	14.9	25.7	3.9
8858	RZM 7230	72	0.0	4.2	9.7	9.7	2.9
8858HO	7851HO x RZM 7230	77	7.8	14.3	31.2	44.2	3.3
8860	RZM 7860	83	0.0	3.6	7.2	16.9	5.1
8861	RZM 7861	76	0.0	1.3	2.6	6.6	4.1
8862	RZM 7862	79	0.0	3.8	7.6	13.9	4.4
8863	RZM 7226	73	0.0	1.4	4.1	8.2	3.8
8863HO	7860HO x RZM 7226	80	0.0	2.5	7.5	22.5	3.5
Monogerm lines							
F82-546	82372, C546	84	0.0	0.0	1.2	1.2	4.7
F78-546H3	78155, C562HO x C546	79	0.0	0.0	6.3	16.5	4.2
F82-546H3	82460, C562HO x C546	82	0.0	1.2	4.9	17.1	4.1
5546	Inc. C546	76	0.0	5.3	10.5	10.5	3.5
F82-562	82196, C562	73	0.0	9.6	19.2	38.4	3.9
F82-562HO	82195, C562HO	83	0.0	6.0	13.3	26.5	3.5
83-718	83246, C718	83	0.0	0.0	1.2	1.2	2.6
83-718HO	83245, C718HO	82	0.0	2.4	2.4	11.0	3.1
F85-796-22	85062, C796-22	75	0.0	0.0	0.0	0.0	2.4
87-309H37	C306CMS x C309	83	0.0	0.0	0.0	1.2	2.4
87-309H3	C562CMS x C309	79	0.0	1.3	2.5	15.2	3.7
87-309H72	C718HO x C309	77	0.0	0.0	0.0	1.3	3.9
87-309H92	C796-22CMS x C309	67	0.0	0.0	0.0	1.5	4.7
87-309	Inc. C309	84	0.0	1.2	3.6	10.7	4.7
87-309CMS	C309CMS	78	0.0	3.8	7.7	14.1	5.2
88-790-68CMS	C790-68HO x C790-68	72	0.0	0.0	1.4	6.9	2.3
88-790-68	Inc. C790-68	72	0.0	0.0	5.6	13.9	1.9
8790-68(E)	ER 6790-68 (C790-68)	73	0.0	0.0	2.7	6.8	1.7
8790-68NB	NB 6790-68 (C790-68)	74	0.0	1.4	2.7	21.6	1.9
8790-92	Inc.6790-92 (C790-92)	76	0.0	0.0	0.0	1.3	4.4

TEST 389. BOLTING EVALUATION AND OBSERVATION TEST OF LINES
SALINAS, CA., 1988-89

(continued)

Variety	Description	Stand[1] Count	Bolting 6/2	Bolting 6/21	Bolting 7/6	Bolting 9/8	P.M.[2] Rating
		No.	%	%	%	%	Avg.
8790-69	Inc. 6790-69(C790-69)	78	0.0	0.0	2.6	19.2	1.5
8796-28	Inc. 6796-28	82	0.0	1.2	2.4	3.7	3.9
8767-20	Inc. 5767-20	77	0.0	0.0	1.3	11.7	3.7
8767-27	Inc. 5767-27	79	15.2	30.4	43.0	49.4	4.4
8767-30	Inc. 5767-30	75	0.0	2.7	5.3	6.7	3.7
8767-44	Inc. 5767-44	91	0.0	5.5	8.8	14.3	2.9
8767-46	Inc. 5767-46	86	0.0	0.0	2.3	8.1	3.5
8767-47	Inc. 5767-47	88	0.0	2.3	12.5	18.2	3.7
7766-8	Inc. T-O 6766-8	82	1.2	2.4	6.1	18.3	3.9
7766-14	Inc. T-O 6766-14	92	0.0	0.0	0.0	0.0	3.8
7766-23	Inc. T-O 6766-23	88	0.0	1.1	4.5	4.5	4.8
8766-23	7766-23	73	0.0	0.0	1.4	6.8	4.7
7766-38	Inc. T-O 6766-38	85	0.0	0.0	0.0	0.0	3.4
7766-44	Inc. T-O 6766-44	88	0.0	0.0	1.1	1.1	2.0
7766-62	Inc. T-O 6766-62	83	0.0	0.0	0.0	2.4	6.8
8766-62	7766-62 selfed	84	0.0	0.0	0.0	1.2	6.6
8807	83-306 selfed	77	0.0	0.0	0.0	2.6	0.9
8833	6833 selfed	83	0.0	1.2	2.6	6.0	2.9
6833	Inc. 5816H50	77	0.0	1.3	1.3	3.9	2.3
6827(C312)	T-O 5827	83	0.0	0.0	2.4	6.0	1.8
6830(C313)	T-O 5830	93	2.2	2.2	3.2	3.2	0.6
6762-17	Inc.2212-17(C762-17)	84	0.0	0.0	0.0	2.4	0.2
88-790-68H26	87-309CMS x C790-68	83	0.0	0.0	2.4	12.0	3.3
88-790-68H92	85-796-22CMSxC790-68	78	0.0	0.0	0.0	6.4	2.7
88-790-68H37	85-306CMS x C790-68	74	0.0	0.0	1.4	9.5	2.5
N801	Inc. B883	75	70.7	90.1	100.0	100.0	6.9
N801A	Inc. B883	56	51.8	85.7	100.0	100.0	7.2
N801B	Inc. B883	66	75.8	87.9	100.0	100.0	7.3
N801H20	87-309H3 x B883	82	1.2	8.5	17.1	22.0	6.6
B801H21	87-309H72 x B883	78	1.3	5.1	15.4	24.4	6.5
N801H24	87-309H92 x B883	86	3.5	8.1	16.3	16.3	6.3
N801H26	87-309CMS x B883	74	0.0	12.2	23.0	31.1	6.1

[1]Total number of plants in 3 replications.
[2]Powdery mildew rated 0 to 9 where 0 = no evidence of disease. Average of ratings made on 7/19, 7/27, 8/9, 8/16 and 8/23/89.

TEST 2989. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION TEST OF LINES, SALINAS, CA., 1989

32 entries x 1 replication
175 entries x 2 replications
1-row plots, 20 ft. long

Planted: May 1, 1989
Inoculated: E.c.b. July 12, 1989
Scored: E.c.b. October 18, 1989

Variety	Description	Roots No.	Erwinia Reaction[1] DI	% Resistant	P.M.[2] Avg.
Multigerm, Open-Pollinated					
86-37	Inc. C37	58	1.4	96.6	4.1
R874	RZM R744	62	5.0	91.9	4.5
R879	RZM 7263	61	0.5	96.7	3.6
768	Inc. 868 (US75)	57	18.2	71.9	4.4
E840	Inc. C40	50	57.0	32.0	4.8
F82-36	82421, C36	53	8.6	79.3	5.6
Y009	Inc. US 22/3	54	7.6	83.3	4.8
964	Inc. 364 (C64)	53	1.9	83.2	2.5
Y748 (C93)	YR-ER-PMR Y548	49	0.3	95.9	2.3
R818	RZM R718(Y54 x B.m.)	63	21.5	63.5	3.9
R821 (C48)	RZM R721	60	21.2	68.3	3.3
R824	RZM 7241	64	9.2	81.3	3.5
R825	RZM 7243	43	16.3	72.1	3.9
R826	RZM 7248	63	9.1	77.8	3.8
R827	RZM 7250	56	14.0	76.8	3.4
R722 (C50)	F3 (SB x B.m.)	50	24.1	54.0	3.0
86-46/2	Inc. C46/2	68	3.2	91.2	1.5
Y846	Inc. Y746	71	2.7	91.6	1.3
Y846(Aa)	Y746 aa x A	64	4.4	92.2	1.4
Y846	YR-ER-PMR Y646	62	0.5	98.4	0.8
R873	Inc. R773	54	2.3	90.7	1.5
R873	RZM R773	54	2.6	92.6	3.0
R878	RZM 7261	39	2.8	87.2	1.1
F86-31/6	86263, C31/6	57	5.3	87.7	1.3
Y731	YR-ER-PMR Y531	72	3.4	87.5	1.3
E840	Inc. C40	49	64.5	26.5	5.9
R871	RZM R771	36	20.4	69.4	3.8
R876	RZM 7259	53	3.7	90.6	1.3
86-92	86165, C92	66	0.0	100.0	1.4
Y752	NB Y552	69	0.4	98.6	1.1
R872	RZM R772	51	10.7	80.4	3.5
R877	RZM 7257	62	0.1	98.4	2.0

TEST 2989. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION TEST OF LINES, SALINAS, CA., 1989
(Continued)

Variety	Description	Roots No.	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
R847C4(C47R)	RZM R747C3	65	1.7	95.4	2.0
R847	Inc. R747C3	68	0.0	100.0	2.4
Y747(C47)	YR-ER-PMR Y547	70	0.2	97.1	0.5
F86-91	86019, C91	52	1.4	98.1	1.0
Y741	YR-ER-PMR Y541(C91)	60	4.2	95.0	0.5
US H11	78442	73	0.7	97.3	4.9
Y854	Inc. Y654	69	2.7	92.8	2.4
Y854(C54)	YR-ER-PMR Y654	73	0.0	100.0	2.0
R875	RZM 7258	49	3.2	91.8	1.6
Y853	YR-ER-PMR Y653	60	8.9	88.3	1.4
8244	Y654 x RZM 7258	69	1.6	95.7	2.0
Y857	YR-ER-PMR Y657	70	1.4	98.6	2.5
R803	RZM R703	40	14.6	75.0	4.1
R813	RZM R713	63	1.3	96.8	1.6
R820(C94)	RZM R720	57	21.8	71.9	2.5
E840	Inc. C40	42	71.1	19.1	5.6
8101(C11T)	YR-ER-PMR 6101	56	0.6	96.4	1.1
8102(C12T)	YR-ER-PMR 6102	61	5.0	88.5	1.4
Y749(C49)	Inc. Y649	64	1.7	95.3	0.9
Y849	YR-ER-PMR Y649	64	0.0	100.0	1.9
Y639(C39)	Inc. Y539	56	2.7	92.9	1.0
R839	Inc. R739(C3)	60	1.8	95.0	0.6
R839(C39R4)	RZM R739(C3)	62	13.0	74.2	1.9
E840	Inc. C40	41	70.7	19.5	5.3
R839-4	RZM R739-4	57	11.6	79.0	0.3
R839-7	RZM R739-7	55	6.1	85.5	1.8
R839-6 (C39R4-6)	RZM R739-6	56	1.2	94.6	0.0
R839-6	Inc. R739-6	52	8.8	82.7	0.5
Multigerm, Self-fertile, A,aa					
5747	4747aa x A	51	6.9	88.2	2.8
7903	6903aa x A	60	0.9	98.3	2.1
8904	YR-ER-PMR 6904	63	0.1	98.4	1.9
8906m	RZM 7906,7mm	52	1.1	84.6	3.0
E840	Inc. C40	52	67.7	26.9	4.3
8906	RZM 7906,7aa x A	57	5.0	87.7	3.5
8906A	RZM 7906,7(A)	55	6.7	78.2	4.3
8908	RZM 7908	44	2.3	97.7	3.4

TEST 2989. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION TEST OF LINES, SALINAS, CA., 1989
(Continued)

Variety	Description	Roots No.	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
8909	RZM 7909	61	1.7	98.4	2.3
8909A	Inc. 7909	62	2.7	96.8	2.4
8909	7909aa x A	65	0.8	98.5	3.5
7909	RZM 6237	57	2.8	93.0	3.0
8910	RZM 7238	52	0.5	98.1	2.9
8911	RZM 7239	65	0.1	98.5	2.6
Monogerm, Self-fertile, A:aa					
8902	T-O sel 6902,7902	48	5.0	83.3	1.5
8722	6722	58	1.3	97.0	2.4
8743(C789/2)	7743aa x A	63	3.3	85.7	3.2
5755(C310/5)	4755aa x A	71	7.4	87.3	3.0
6756(C310/6)	5756Zaa x A	73	2.5	94.5	1.9
8755(C310)	7755,6aa x A	56	4.3	87.5	2.8
8755HO	6756HO x 7755,6	68	9.3	82.4	2.3
8787	7755-7797aa x A	72	7.0	77.8	3.6
8247	7767aa x RZM 7224,5	65	4.9	89.2	3.6
7767	6767aa x A	65	6.2	86.2	2.0
8767	NB 6767 (A,aa)	69	16.0	75.4	2.0
7776	6776aa x A	75	4.1	86.7	2.9
8776	NB 6776 (A,aa)	69	9.6	85.5	3.0
7790L(C790)	5790aa x A	74	14.3	71.6	3.5
8790	7790Laa x A	67	11.1	71.6	2.5
8790HO	7790LHO x 7790L	67	9.0	74.6	3.1
7797	YR-ER-PMR 5797	58	4.5	86.2	3.6
E840	Inc. C40	42	69.4	21.4	4.6
8796(C796)	7796aa x A	53	12.6	81.1	4.1
8796HO	5796HO x 7796	59	11.2	64.4	5.0
8850	RZM 7850	30	13.8	70.0	6.6
8850HO	8550HO x RZM 7850	37	15.5	70.3	5.5
8851	RZM 7851 (C566)	43	18.6	67.4	5.3
8852	RZM 7852	37	22.0	56.8	4.5
8852HO	7852HO x RZM 7852	41	19.7	61.0	4.5
8853	RZM 7853	32	20.8	65.6	3.6
8854	RZM 7854(C566 type)	43	21.2	53.5	5.6
8855	RZM 7855(C309 type)	48	18.6	62.5	4.8
8856	RZM 7228(C310 type)	53	15.7	67.9	2.9
8857	RZM 7224(767 type)	43	21.3	55.8	4.9

TEST 2989. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION TEST OF LINES, SALINAS, CA., 1989
(Continued)

Variety	Description	Roots No.	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
8857HO	7852HO x RZM 7224,5	39	17.2	61.5	4.5
8858	RZM 7230 (C566 type)	27	12.6	74.1	4.6
8858HO	8851HO x RZM 7230	30	22.2	46.7	4.0
8860	RZM 7860	46	16.5	69.6	5.0
8861	RZM 7861	42	26.3	59.5	4.3
8862	RZM 7862	51	9.5	70.6	4.5
8863	RZM 7226 (776 type)	52	14.7	71.2	3.9
8863HO	7860HO x RZM 7226	57	12.7	64.9	3.9
Monogerm Lines					
F82-546	82372, C546	38	3.2	86.8	4.3
F78-546H3	78155, C562HO x C546	17	5.3	76.5	5.1
F82-546H3	82460, C542HO x C546	49	5.0	79.6	5.8
5546	Inc. F82-546	23	15.7	60.9	5.0
F82-562	82196, C562	49	6.1	65.3	5.3
F82-562HO	82195, C562HO	36	7.6	58.3	5.3
83-718HO	C718	49	11.2	67.4	5.6
83-718HO	C718HO	28	8.5	53.6	4.9
E840	Inc. C40	47	82.6	10.6	5.8
F85-796-22	85062, C796-22	34	4.1	88.2	4.1
87-309H37	C306 x C309	71	12.7	69.0	4.1
87-309H3	C562 x C309	66	2.3	87.9	4.6
87-309H72	C718 x C309	67	3.4	83.6	4.4
87-309H92	C796-22 x C309	65	6.7	70.8	4.8
87-309	C309	74	6.7	75.7	4.8
87-309CMS	C309CMS	67	10.5	71.6	5.1
8246(C)	C309aa x RZM 7855	61	6.1	82.0	5.0
5742-24	Inc.1742-24(C742-24)	43	10.3	72.1	2.8
5796-43	Inc.2796-43(C796-43)	44	3.2	88.6	4.0
88-790-68CMS	6790-68HO x 6790-68	51	7.3	80.4	3.5
88-790-68	Inc.6790-68(C790-68)	55	15.2	63.6	2.6
8790-68(E)	ER 6790-68	53	12.2	62.3	2.9
8790-68NB	NB 6790-68	28	15.3	57.1	3.1
8790-92	Inc.6790-92(C790-92)	59	20.1	61.0	6.6
8790-69	Inc.6790-69(C790-69)	40	0.2	97.5	1.4
8796-28	Inc. 6796-28	51	1.3	94.1	5.0
8767-20	Inc. 5767-20	50	0.0	100.0	2.9
8767-27	Inc. 5767-27	39	8.1	84.6	3.5

TEST 2989. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION TEST OF LINES, SALINAS, CA., 1989
(Continued)

Variety	Description	Roots No.	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
8767-30	Inc. 5767-30	49	0.4	93.9	2.9
8767-44	Inc. 5767-44	40	24.2	37.5	2.4
8767-46	Inc. 5767-46	65	3.5	87.7	4.5
E840	Inc. C40	45	81.1	6.7	5.6
7766-8	T-O 6766-8	51	1.9	90.2	3.8
7766-14	T-O 6766-14	26	7.2	69.2	3.6
7766-23	T-O 6766-23	55	4.6	85.5	3.8
5766-23	Inc.2216-23(C766-23)	51	20.1	60.8	3.6
7766-62	T-O 6766-62	33	1.9	90.9	5.3
5766-62	Inc. 2216-62	9	0.0	100.0	4.4
8807	T-O C306	21	28.8	38.1	2.6
8833	T-O 6833	42	8.0	81.0	3.5
6833	Inc. (C309aa x C303)	55	13.8	72.7	3.5
6827	T-O 5827 (C312)	56	11.0	76.8	2.1
E840	Inc. C40	38	58.5	21.1	5.8
6830	T-O 5830 (C313)	32	38.2	34.4	1.6
88-790-68H26	C309CMS x C790-68	75	17.1	65.3	4.6
88-790-68H92	C796-22CMS x C790-68	68	6.4	70.6	2.5
88-790-68H37	C306CMS x C790-68	63	25.2	44.4	2.4
Nematode Resistant Lines & Hybrids					
N801	Inc. B883	21	15.6	57.1	6.3
N801A	Inc. B883	24	33.4	62.5	7.1
N801B	Inc. B883	25	15.1	56.0	6.4
USH11	786442	59	1.7	81.4	5.0
N801H20	87-309H3 x B883	77	15.3	68.8	4.9
N801H(Blend)	87-309H x B883	82	20.6	59.8	5.4
N801H(Blend)	87-309H x B883	80	22.3	55.0	5.8
N801H26	87-309CMS x B883	74	31.4	48.7	4.8
8250	R773 x 88N-F1	55	4.6	92.7	4.1
8250P	Inc. 88N-F1	61	18.9	70.5	5.0
8254	7908aa x 88N-F1	55	5.0	92.7	4.9
8254P	Inc. 88N-F1	51	19.5	60.8	6.6
8260	7852aa x 88N-F1	64	12.1	78.1	5.8
8260P	Inc. 88N-F1	60	15.6	68.3	6.6
8265	Inc. 88N-F1	45	21.3	53.3	7.3
E840	Inc. C40	43	74.4	16.3	7.4

TEST 2989. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION AND OBSERVATION TEST OF LINES, SALINAS, CA., 1989
(Continued)

Variety	Description	Roots No.	Erwinia Reaction[1] DI	Erwinia Reaction[1] % Resistant	P.M.[2] Avg.
1 Replication, S_2 Lines					
8852 - 7	7852-7 selfed	22	0.0	100.0	4.8
8852 - 14	7852-14 selfed	29	4.3	93.1	4.3
8852 - 19	7852-19 selfed	6	16.7	83.3	4.5
8852 - 40	7852-40 selfed	2	0.0	100.0	0.0
8852 - 41	7852-41 selfed	1	7.0	0.0	4.3
8852 - 42	7852-42 selfed	3	8.3	66.7	5.5
8852 - 62	7852-62 selfed	5	0.0	100.0	3.5
8852 - 64	7852-64 selfed	10	18.2	60.0	1.5
8852 - 69	7852-69 selfed	21	1.0	85.7	4.5
8852 - 73	7852-73 selfed	6	5.7	66.7	5.5
8855 - 5	7855-5 selfed	10	0.0	100.0	2.8
8855 - 8	7855-8 selfed	24	2.4	87.5	3.5
8855 - 9	7855-9 selfed	20	24.4	75.0	3.5
8855 - 17	7855-17 selfed	17	15.4	76.5	7.5
8855 - 21	7855-21 selfed	6	32.2	33.3	4.8
8855 - 38	7855-38 selfed	6	4.2	83.3	7.0
8855 - 41	7855-41 selfed	8	25.0	62.5	6.0
8855 - 48	7855-48 selfed	19	18.8	63.2	6.5
8855 - 56	7855-56 selfed	10	67.5	20.0	5.8
8855 - 62	7855-62 selfed	37	18.8	59.5	7.8
8852 - 22	7852-22 selfed	16	18.8	68.8	4.0
8852 - 27	7852-27 selfed	10	62.5	30.0	3.8
8852 - 35	7852-35 selfed	10	36.4	20.0	5.3
8852 - 45	7852-45 selfed	14	1.5	78.6	7.0
8852 - 48	7852-48 selfed	17	6.4	76.5	7.0
8852 - 54	7852-54 selfed	18	6.3	72.2	5.0
8852 - 72	8852-72 selfed	8	7.3	62.5	3.5
8855 - 6	7855-6 selfed	4	20.5	25.0	7.3

[1] DI=disease index=approximate amount of rotted tissue. % Resistant= % of roots with less than 1% rot. Disease severity was moderate.

[2] Area under disease progress curve where 0=0% leaf area infected to 9=90-100% of leaf area covered. Mean of ratings made on 8/18, 8/24, 8/29 and 9/89. Disease severity was moderate.

TEST 3189. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION OF HYBRIDS, SALINAS, CA., 1989

120 entries x 2 reps
1-row plots, 20 ft. long

Planted: May 1, 1989
Inoculated: E.c.b. July 13, 1989
Scored: E.c.b. Oct. 26, 1989

Variety	Description	Roots	Erwinia Reaction[1]		P.M.[2]
		No.	DI	% Resistant	Avg.
US H11	Resist. ck.	65	0.7	90.8	5.1
E840	Susc. ck.	60	59.8	21.7	5.4
US H10B	Int.'m ck.	46	7.1	80.4	5.3
Vyncemono	Van der Have	66	3.1	83.3	4.0
Rima	SES	71	1.5	97.2	3.8
6625	Betaseed	68	1.7	94.1	2.9
KW1745	Betaseed	76	1.6	93.4	2.5
4757	Betaseed	76	1.1	96.1	2.9
SSZ2	Spreckels	70	2.2	91.4	5.9
SSNB3	Spreckels	65	1.2	96.9	5.4
HH37	Holly	55	2.5	89.1	4.0
HH41	Holly	66	2.5	90.9	3.9
HH52	Holly	66	3.2	92.4	3.8
Rhizosen	Holly	71	3.9	90.1	4.3
USC-4	Union	70	2.9	88.6	3.1
USC-5	Union	61	0.2	98.4	3.6
Y731H8	C546H3 x C31/6	61	1.1	93.4	3.3
E840H72	C718HO x E40	70	25.5	55.7	5.3
Y731H20	C309H3 x C31/6	67	3.7	86.6	3.4
Y731H23	C309H37 x C31/6	71	8.9	76.1	3.8
Y731H26	C309CMS x C31/6	76	5.7	88.2	4.0
E840	Susc. ck.	57	52.8	33.3	5.4
Y731H42	C742-24HO x C31/6	69	1.3	95.7	3.0
Y731H66	C766-23HO x C31/6	72	5.1	86.1	3.0
Y731H70	C766-62HO x C31/6	67	0.3	95.5	3.3
US H11	Resist. ck.	60	0.1	98.3	4.9
Y731H72	C718HO x C31/6	60	4.8	81.7	2.9
Y731H89	C790-68HO x C31/6	55	2.3	96.4	2.5
Y731H92	C796-22CMS x C31/6	67	2.7	91.0	3.4
Y731H37	C306CMS x C31/6	61	7.1	85.3	3.5
Y731H24	C309H92 x C31/6	59	2.5	91.5	4.1
7903H8	C546H3 x 6903	74	1.1	96.0	4.9
7093H26	C309CMS x 6903	87	0.8	94.3	5.4
7906H8	C546H3 x 6235,6,7	69	4.2	88.4	5.3
USH10B	Int.'m ck.	44	13.2	68.2	5.9

TEST 3189. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION OF HYBRIDS, SALINAS, CA., 1989
(Continued)

Variety	Description	Roots Erwinia Reaction[1] No.	DI	% Resistant	P.M.[2] Avg.
E840H72	C718HO x E40	68	33.0	44.1	6.0
7906H26	C309CMS x 6235,6,7	60	7.9	81.7	6.3
R847H8	C546H3 x R747(C47R)	70	1.0	94.3	4.5
R847H26	C309CMS x R747(C47R)	79	4.5	86.1	4.9
R839-6H8	546H3 x R739-6(C39R-6)	68	6.1	86.8	2.1
R839-6H26	C309CMS x R739-6(C39R-6)	66	7.0	83.3	2.8
8909H8	C546H3 x 7909	61	2.4	90.2	4.0
8909H26	C309CMS x 7909(C39R)	67	1.9	91.0	5.5
R839H8	C546H3 x R739C3	57	1.8	94.7	3.5
USH11	Resist. ck.	57	1.1	89.5	4.5
R839H20	C309H3 x R739C3(C39R)	58	7.9	81.0	3.3
R839H23	C309H37 x R739C3(C39R)	58	6.7	87.9	2.6
R839H26	C309H92 x R739C3(C39R)	71	2.7	95.8	3.3
E840	Susc. ck.	50	57.6	26.0	5.5
R873H8	C546H3 x R773	56	2.0	87.5	3.8
R873H20	C309H3 x R773	57	0.8	93.0	3.6
R873H23	C309H3 x R773	54	1.5	94.4	3.5
Y854H8	C546H3 x Y654(C54)	71	0.8	97.2	4.1
Y854H20	C309H3 x Y654(C54)	73	9.8	80.8	4.1
Y854H23	C309H37 x Y654(C54)	63	2.7	90.5	2.9
Y854H26	C309CMS x Y654	67	0.5	94.0	2.9
Y854H37	C306CMS x Y654	58	1.7	96.6	2.1
Y854H66	C766-23HO x Y654	68	2.9	91.2	3.4
Y854H70	C766-62HO x Y654	63	0.5	96.8	4.4
Y854H89	C790-68HO x Y654	59	1.1	94.9	3.8
E840	Susc. ck.	46	38.2	45.7	4.9
Y846H3	C562HO x Y746(C46/3)	71	1.6	93.0	3.0
Y846H8	C546H3 x Y746	63	2.3	90.5	3.5
US H11	Resist. ck.	69	2.4	84.1	6.0
Y846H13	C546H92 x Y746	58	1.2	87.9	2.4
Y846H20	C309H3 x Y746	56	4.1	82.1	3.5
Y846H21	C309H72 x Y746	63	4.7	81.0	3.0
Y846H23	C309H37 x Y746	63	1.7	95.2	2.9
Y846H24	C309H92 x Y746	65	1.8	89.2	3.4
Y846H26	C309CMS x Y746	60	1.3	90.0	4.1

TEST 3189. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION OF HYBRIDS, SALINAS, CA., 1989
(Continued)

Variety	Description	Roots Erwinia Reaction[1] No.	DI	% Resistant	P.M.[2] Avg.
Y846H37	C306CMS x Y746	61	3.8	90.2	2.6
Y846H38	C312HO x Y746	54	7.5	81.5	2.0
E840H72	C718HO x E40	47	34.4	40.4	5.8
US H10B	Int.'m ck.	41	12.4	73.2	5.9
Y846H39	C762-17HO x Y746	58	0.2	96.6	2.0
Y846H66	C66-23HO x Y746	73	0.4	98.6	2.5
Y946H70	C66-62HO x Y746	71	0.3	95.8	3.3
Y846H72	C718HO x Y746	61	6.0	80.3	3.4
Y846H84	C790-69HO x Y746	62	0.3	95.2	2.4
Y846H85	C790-92HO x Y746	65	4.4	78.5	3.5
Y846H89	C790-68HO x Y746	66	5.5	81.8	2.9
Y846H92	C796-22CMS x Y746	50	6.4	88.0	3.5
Y846H94	C796-28HO x Y746	70	0.8	92.9	3.5
US H11	Resist. ck.	58	3.7	84.5	6.0
Y846H97	C796-43HO x Y746	67	2.0	89.6	2.0
Y846H50	5767-20aa x Y746	56	1.8	89.3	1.9
E840	Susc. ck.	46	49.8	32.6	5.0
Y846H51	5767-27aa x Y746	58	3.0	89.7	3.3
Y846H52	5767-30aa x Y746	45	0.5	93.3	2.3
Y846H53	5767-44aa x Y746	45	3.0	91.1	2.3
Y846H54	5767-46aa x Y746	55	0.3	96.4	3.1
Y846H61	7766-8HO x Y746	59	1.2	91.5	3.6
Y846H62	7766-14HO x Y746	55	0.7	94.6	3.4
Y846H36	C790aa x Y746	64	3.1	90.6	2.8
Y846H67	7767aa x Y746	66	1.7	90.9	2.3
Y846H68	7767HO x Y746	56	0.6	96.4	2.0
Y846H76	7776aa x Y746	63	4.2	90.5	2.4
Y846H77	7776HO x Y746	65	0.5	93.9	2.6
US H11	Resist. ck.	70	2.5	91.4	5.0
Y846H82	C310/6aa x Y746	64	1.1	92.2	2.8
Y846H83	C310/6HO x Y746	51	2.4	92.2	1.8
Y846H96	C796aa x Y746	56	2.3	87.5	3.3
E840	Susc. ck.	46	60.1	28.3	5.4
Y846H100	7850aa x Y746	52	3.7	76.9	2.8
Y846H101	7851aa x Y746	59	1.6	91.5	2.6

TEST 3189. ERWINIA ROOT ROT AND POWDERY MILDEW
EVALUATION OF HYBRIDS, SALINAS, CA., 1989
(Continued)

Variety	Description	Roots Erwinia Reaction[1] No.	DI	% Resistant	P.M.[2] Avg.
Y846H102	7852aa x Y746	51	4.4	90.2	2.1
Y846H103	7853aa x Y746	59	5.5	88.1	2.8
Y846H104	7854aa x Y746	66	5.2	87.9	2.6
E840H72	C718HO x E40	60	36.1	41.7	5.4
Y846H105	7855aa x Y746	62	7.6	87.1	3.9
Y846H106	7860aa x Y746	60	4.0	91.7	2.9
Y846H107	7861aa x Y746	64	3.8	78.1	2.5
US H11OB	Int.'m ck.	39	10.4	79.5	4.6
Y846H108	7862aa x Int.'m ck.	58	3.1	91.4	3.1
Y846H109	R702HO x Int.'m ck.	56	2.4	94.6	2.4
Y846H110	7850HO x Y746	46	1.3	93.5	2.1
Y846H114	7224,5aa x Y746	62	3.8	93.6	2.6
Y846H115	7226aa x Y746	65	1.1	93.9	3.1
Y846H116	7228aa x Y746	68	0.1	98.5	2.1
Y846H117	7230aa x Y746	53	0.9	92.5	4.0

[1] DI=disease index=approximate amount of rotted tissue.
% Resistant=% of roots with less than 1% rot. ERR incidence was mild to moderate.

[2] Area under disease progress curve where 0=0% leaf area infected to 9=90-100% of leaf area covered. Mean of ratings made on 8/19, 8/24, 8/29, and 9/7/89. Disease was moderate.

TEST 2789. POWDERY MILDEW EVALUATION OF
TEST AND MARKET HYBRIDS, SALINAS, CA., 1989

Planted: May 1, 1989
96 entries x 5 replications
1-row plots, 16 ft. long

Entry No.	Variety	Co.[3]	No. Plants[1]	Powdery Mildew Rating[2] 8/18	8/24	8/29	9/7	Mean
89-PM-1	H85207	SS	120	2.6	3.6	5.0	6.6	4.5
-2	USH11	Ck.	135	3.0	4.8	6.2	7.6	5.4
-3	6BG6209	B	132	1.0	2.0	2.6	3.2	2.2
-4	6BC6280	B	141	0.8	2.0	2.2	3.0	2.0
-5	86C-13-010	HS	130	3.6	4.2	5.0	6.0	4.7
-6	87C 40-07	HS	117	3.2	4.0	4.8	6.2	4.6
-7	84C 39-027	HS	138	2.6	3.6	4.6	5.8	4.2
-8	87C 144-04	HS	134	2.4	3.4	4.2	6.0	4.0
-9	4BG5549	B	140	1.2	3.0	3.6	4.8	3.2
-10	H84181	SS	136	2.0	3.8	4.8	5.8	4.1
-11	86C 148-04	HS	147	2.8	3.8	4.6	6.6	4.5
-12	4BX8823	B	126	0.4	1.2	2.2	3.2	1.8
-13	87C 40-011	HS	130	2.6	3.8	4.6	6.8	4.5
-14	USC-1	HS	139	2.2	3.6	5.0	6.2	4.3
-15	7BG6088	B	133	0.4	1.6	2.8	3.6	2.1
-16	H84377	SS	135	2.4	3.6	5.2	6.4	4.4
-17	7BG6164	B	142	1.0	2.6	4.0	4.8	3.1
-18	SS-270	SS	136	2.4	3.2	4.8	6.0	4.1
-19	USH11	Ck.	124	3.6	4.6	6.8	7.6	5.7
-20	H85231	SS	146	1.8	3.2	3.8	4.6	3.4
-21	6BG6151	B	133	2.0	3.6	4.6	6.8	4.3
-22	HH-37	HS	122	1.6	3.6	4.0	5.2	3.6
-23	86-84C25-020	HS	142	2.8	3.8	5.0	5.6	4.3
-24	USC-4	HS	131	2.4	3.6	4.6	5.6	4.1
-25	H85211	SS	142	2.6	4.0	5.6	7.6	5.0
-26	84C 39-015	HS	122	2.2	3.4	4.2	5.6	3.9
-27	86C 15-016	HS	131	4.0	5.2	7.2	8.6	6.3
-28	84C 39-024	HS	134	2.4	3.6	4.8	6.0	4.2
-29	SS-LS2	SS	131	3.0	4.0	5.0	6.0	4.5
-30	86-1459-029	HS	133	3.4	4.4	5.8	7.0	5.2
-31	USH11	Ck.	107	4.2	5.2	6.8	7.6	6.0
-32	87C 40-010	HS	108	4.0	5.0	6.8	8.0	6.0
-33	H85364	SS	144	1.8	2.8	4.6	5.0	3.6
-34	86-84C80-019	HS	131	2.8	3.6	5.6	5.8	4.5
-35	SS-NB2	SS	129	2.4	4.0	5.6	7.0	4.8
-36	84C 39-022	HS	120	2.4	3.4	5.2	6.2	4.3

TEST 2789. POWDERY MILDEW EVALUATION OF
TEST AND MARKET HYBRIDS, SALINAS, CA., 1989

Entry No.	Variety	Co.[3]	No. Plants[1]	Powdery Mildew Rating[2] 8/18	8/24	8/29	9/7	Mean
89-PM-37	SS-Z2	SS	107	3.6	4.4	6.4	7.2	5.4
-38	SS-Y1	SS	138	2.4	3.2	4.8	5.6	4.0
-39	4757	B	137	0.8	1.4	3.2	4.0	2.4
-40	4654	B	146	2.8	3.6	4.4	5.6	4.1
-41	H83165	SS	131	3.6	4.0	5.4	7.2	5.1
-42	6BG6165	B	133	1.4	2.6	4.2	4.8	3.3
-43	HH-41	HS	133	2.0	3.8	4.6	5.4	4.0
-44	84C 39-033	HS	117	2.4	3.6	4.8	5.8	4.2
-45	87C 34-09	HS	96	2.8	4.0	5.2	7.2	4.8
-46	H87538	SS	146	1.2	2.0	3.0	5.0	2.8
-47	86C 14-05	HS	148	2.6	4.2	5.2	6.8	4.7
-48	86C 15-014	HS	150	2.2	3.2	4.0	5.2	3.7
-49	4625	B	153	1.4	2.2	3.0	4.0	2.7
-50	4587	B	113	2.6	3.6	4.6	5.4	4.1
-51	HH-46	HS	151	2.2	3.6	4.4	5.2	3.9
-52	HH-38	HS	115	1.0	2.6	3.4	4.4	2.9
-53	Hill 2	H	102	0.6	1.8	2.6	3.6	2.2
-54	87C 153-016	HS	125	3.2	4.2	4.8	6.8	4.8
-55	SS-Z1	SS	104	2.8	4.0	5.4	6.8	4.8
-56	86-84C36-012	HS	103	3.2	4.2	5.2	7.0	4.9
-57	4480	B	122	2.2	3.6	4.0	5.6	3.9
-58	7BG7111	B	107	1.2	2.4	3.0	4.0	2.7
-59	HM 3008	H	125	2.2	3.6	4.6	5.4	4.0
-60	87C 40-09	HS	108	3.4	4.6	6.4	7.2	5.4
-61	6BG6085	B	136	0.6	1.4	2.6	3.4	2.0
-62	H85333	SS	155	1.2	2.4	2.6	3.8	2.5
-63	HM 3007	H	137	1.0	2.4	3.0	3.4	2.5
-64	6BG6162	B	120	2.2	3.6	4.4	5.4	3.9
-65	Hill 1	H	129	0.6	1.2	2.0	3.2	1.8
-66	H86461	SS	150	1.8	3.4	3.8	5.0	3.5
-67	HH-54	HS	142	2.2	3.8	4.6	6.8	4.4
-68	HH-52	HS	158	2.6	3.4	4.6	6.4	4.3
-69	USH-11	SV	137	3.6	4.8	7.0	8.8	6.1
-70	USC-5	HS	141	1.4	3.4	3.8	5.8	3.6
-71	H87353	SS	140	1.8	3.6	4.4	5.8	3.9
-72	H86178	SS	142	2.2	3.4	4.0	5.6	3.8

TEST 2789. POWDERY MILDEW EVALUATION OF
TEST AND MARKET HYBRIDS, SALINAS, CA., 1989

Entry No.	Variety	Co.[3]	No. Plants[1]	Powdery Mildew Rating[2] 8/18	8/24	8/29	9/7	Mean
89-PM-73	H86502	SS	143	2.0	3.4	4.2	4.8	3.6
-74	HH-51	HS	147	1.4	2.8	3.6	4.8	3.2
-75	6BG6207	B	146	0.0	1.0	1.2	2.6	1.2
-76	86-84C80-05	HS	125	1.0	1.6	1.8	2.6	1.8
-77	HM 3006	H	135	1.0	2.0	3.0	4.6	2.7
-78	HM 6036	H	138	1.6	2.6	3.6	4.8	3.2
-79	84C 39-029	HS	140	2.2	3.0	4.0	5.2	3.6
-80	Rhizosen	HS	128	1.6	3.0	3.6	6.0	3.6
-81	86-84C65-06	HS	133	0.8	3.2	3.4	4.2	2.9
-82	87C-40-08	HS	100	2.2	3.0	5.0	6.6	4.2
-83	HH-45	HS	133	1.8	3.2	4.0	5.4	3.6
-84	86-84C25-013	HS	121	1.6	2.8	4.0	5.2	3.4
-85	SS-NB3	SS	113	2.2	3.6	5.2	6.4	4.4
-86	HM 3005	H	130	2.2	3.8	4.8	6.4	4.3
-87	HM 6027	H	141	1.8	3.6	4.0	4.2	3.4
-88	87C-40-012	HS	120	3.6	4.2	6.0	7.4	5.3
-89	SS-334	SS	133	1.8	2.8	4.0	4.8	3.4
-90	HH-55	HS	130	0.0	1.4	1.8	2.2	1.4
USH 11	USDA	Susc. ck.	131	3.6	4.4	6.0	7.2	5.3
USH 11	USDA	Susc. ck.	135	3.8	4.6	6.4	7.4	5.6
F86-91	USDA	Resist. ck.	108	0.6	1.0	1.2	1.6	1.1
F86-91	USDA	Resist. ck.	113	0.4	0.8	0.8	1.4	0.9
F86-91	USDA	Resist. ck.	121	0.6	1.2	1.6	3.2	1.7
F86-91	USDA	Resist. ck.	121	0.2	0.4	0.8	2.2	0.9
Mean				2.1	3.2	4.3	5.5	3.8
LSD (.05)				1.3	1.1	1.4	1.6	1.1

[1] Total number of plants over five replications.

[2] Powdery mildew scored on 8/18, 8/24, 8/29, and 9/7/89 where 0 = 0% leaf area infected to 9 = 90-100% covered. Mean approximately equals area under disease progress curve. Disease severity was only moderate but relative ratings appeared to be reliable. The five entries of US H11 gave consistent results.

[3] Company designation: H = Hilleshog, B = Betaseed, HS = Holly, and SS = Spreckels.

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1989

150 entries x 3 replications
1-row plots, 20 ft. long

Test Conducted by Terry Brown, BSDF

Variety	Description MS	T-O	Male	CT Grade[1] 1st Rating	2nd Rating	
CHECKS						
US 33	Check (I)			5.9	6.0	*
US 41	Check (R)			5.2	5.4	*
HYBRIDS						
US H11	C562	C546	C36	4.4	4.7	
Vyncemono	Van der Have			6.4	6.8	
Rima	SES			7.7	8.2	
SS NB3	Spreckels			5.8	5.7	
4757	Betaseed			6.4	6.6	
Rhizosen	Holly			7.3	7.3	
N801H20	C562	C309	B883	6.0	6.5	
Y846H20	C562	C309	C46/3	5.3	5.5	
Y846H8	C562	C546	C46/3	4.5	5.1	
R873H8	C562	C546	R73	5.0	5.3	
Y854H8						
R847H8	C562	C546	C47R	4.9	5.3	

Variety	Description MS	T-O	Male	CT Grade 1st Rating	2nd Rating
HYBRIDS					
Y731H8	C562	C546	C31/6	5.2	5.9
R839H8	C562	C546	C39R	5.1	5.3
7903H8	C562	C546	903	4.9	4.9
7906H8	C562	C546	906	5.7	5.5
890H8	C562	C546	909	5.6	5.7
Y846H26	C309		C46/3	5.7	5.6
R873H26	C309		R73	5.8	5.9
Y854H26	C309		C54	6.0	5.8
R847H26	C309		C47R	5.9	5.9
Y731H26	C309		C31/6	6.2	6.4
R839H26	C309		C39R	5.7	5.7
7903H26	C309		903	5.2	5.1
7906H26	C309		906	6.0	5.9

[1] Mean of 3 replications read by three scorers (9 observations per mean) and five scorers (15 observations per mean) for 1st and 2nd dates, respectively.

* = average of 22 to 25 times repeated in test

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1989
(continued)

Variety	Description MS	T-O	Male	CT Grade 1st Rating	2nd Rating
HYBRIDS					
8909H26	C309		909	5.8	5.7
Y854H66	C766-23		C54	6.2	6.1
Y854H70	C766-62		C54	6.0	5.9
US H11	C562	C546	C36	5.4	5.4
Y846H3	C562		C46/3	5.3	5.4
Y846H23	C306	C309	C46/3	5.9	5.9
Y846H37	C306		C46/3	5.6	5.6
Y846H38	C312		C46/3	5.3	5.6
Y846H39	C762-17		C46/3	4.2	4.5
Y846H54	767-46		C46/3	5.6	5.5
Y846H66	C766-23		C46/3	5.4	5.5
Y846H70	C766-62		C46/3	4.8	5.3
Y846H72	C718		C46/3	4.7	4.7
Y846H84	C790-69		C46/3	4.6	4.7
Y846H85	C790-92		C46/3	4.9	5.0
Y846H89	C790-68		C46/3	5.2	5.0
Y846H92	C796-22		C46/3	4.4	3.9
Y846H97	C796-43		C46/3	5.0	4.7
Y846H67	popn-767		C46/3	5.0	4.7
Y846H76	popn-776		C46/3	4.1	3.8
Y846H104	popn-854		C46/3	4.6	4.0
Y846H105	popn-855		C46/3	4.8	4.5
Y846H114	popn-857		C46/3	5.2	5.0
Y846H115	popn-863		C46/3	5.7	5.5

Variety	Description	CT Grade 1st Rating	2nd Rating
MM, OPEN-POLLINATED			
P1-9	Polish acc. 1988 (2n%S)	7.3	7.1
8101	C11T	7.8	7.6
8102	C12T	7.7	7.3
82-36	C36	6.0	6.0
Y009	US22/3	5.6	5.6
768	US75	5.0	5.1
86-37	C37	4.7	4.6
R874	Rhizom. resist. C37	5.4	5.4
R879	Rhizom. resist. C37	5.5	5.2
R821	C37 x (C37xB.m.)	5.2	5.3
R824	C37 x [C37x(C37xB.m.)]	4.8	5.0
R825	C37 x [C37x(C37xB.m.)]	5.3	5.2
Y854	C54	6.0	6.0
Y854	C54 source	6.0	5.9
R875	Rhizom. resist. C54	6.1	6.3
R722	F_3(Y54 x B.m.)(C50)	6.6	6.3
R818	Rhizom. resist. (Y54 x B.m.)	7.3	7.3
86-31/6	C31/6	7.1	7.0
Y731	C31/7	6.8	6.9
R871	Rhizom. resist. C31	6.1	6.5
R876	Rhizom. resist. C31	6.0	6.4
R872	Rhizom. resist. C92	6.0	6.3
R877	Rhizom. resist. C92	6.6	6.5
86-46/2	C46/2	6.0	6.0

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1989
(continued)

Variety	Description			CT Grade 1st Rating	CT Grade 2nd Rating
	MS	T-O	Male		
MM, OPEN-POLLINATED					
Y846	C46/4			6.0	6.1
R873	Rhizom. resist. C46			6.0	6.1
R878	Rhizom. resist. C46			5.9	5.3
Y639	C39			7.0	6.7
R839C4	C39R4			6.1	5.9
R839-6	C39R-6			6.6	6.5
Y747	C47			6.2	6.3
R847	C47R			6.2	6.2
R847C4	C47R			7.1	6.7
Y748	C93			6.3	6.5
Y849	C49			7.0	7.1
Y853	[C46 x (3N-CMS-%SxC46)]2N			7.6	7.7
Y857	[C46 x (3N-CMS-%SxC46)]2N			6.3	6.3
R820	C94			7.6	7.5
N801	B883, Netherlands			6.8	7.2
MM, S^f, A:aa POPULATIONS					
5747	popn-747 (C37 type)			5.6	5.7
7903	popn-903 (C46 type)			5.2	5.3
8904	popn-904 (C39 type)			5.4	5.8
8906	popn-906			5.8	6.5
8908	popn-908			5.4	5.8
8909	popn-909(I)			5.5	6.2
8909	popn-909(S)			5.1	5.1
8910	popn-910			5.6	5.7
8911	popn-911			5.9	6.1

Variety	Description	CT Grade 1st Rating	CT Grade 2nd Rating
mm, S^f, A:aa POPULATIONS			
8722	popn-722	6.3	6.8
8743	popn-C789/2	5.2	4.7
8755	popn-C310/6	5.3	5.5
8767	popn-767	5.9	6.1
8776	popn-776	6.4	6.2
8787	popn-787	5.2	5.4
8790L	popn-C790	5.2	5.3
8796	popn-C796	5.3	5.3
8850	Rhizom. resist. C563 (50%)	6.0	6.3
8851	Rhizom. resist. C563 (75%)	6.1	6.2
8852	Rhizom. resist. popn-767 (75%)	6.1	6.4
8853	Rhizom. resist. popn-C310(75%)	6.0	6.5
8854	Rhizom. resist. C563 (87%)	5.0	5.1
8855	Rhisom. resist. C309 (50%)	6.0	6.2
8856	Rhizom. resist. popn-C310(87%)	5.7	5.9
8857	Rhizom. resist. popn-767 (87%)	5.3	5.4
8858	Rhizom. resist. C563 (92%)	4.9	4.9
8860	Rhizom. resist. popn-776 (50%)	6.9	6.6
8861	Rhizom. resist. popn-776 (75)	6.6	6.3
8862	Rhizom. resist. popn-776 (87)	6.4	6.7
8863	Rhizom. resist. popn-776 (92)	5.9	5.8

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1989
(continued)

Variety	Description MS	T-O	Male	CT Grade 1st Rating	2nd Rating
mm, S^f LINES					
8502	NB1 inbred			4.1	3.7
88-790-68	C790-68			5.4	6.3
88-68CMS	C790-68CMS			6.3	5.9
88-68H26	C309 x C790-68			6.1	5.8
88-68H37	C306 x C790-68			5.1	5.3
88-68H92	C796-22 x C790-68			4.8	4.9
82-546H3	C562 x C546			4.2	4.2
87-309H3	C562 x C309			4.3	4.3
87-309H37	C306 x C309			4.9	4.9
87-309H92	C796-22 x C309			4.9	4.0
87-309CMS	C309CMS			5.9	5.5
87-309	C309			6.2	5.7
82-562	C562			4.8	4.3
82-562HO	C562CMS			4.8	4.1
7766-8	Inc. S_2 from popn-767			5.3	5.3
7766-14	Inc. S_2 from popn-767			4.8	4.9

Variety	Description	CT Grade 1st Rating	2nd Rating
mm, S^f LINES			
7766-23	C766-23	6.4	6.4
7766-62	C766-62	5.6	5.6
8767-20	Inc. S_1 from popn-767	6.3	6.6
8767-27	Inc. S_1 from popn-767	6.2	6.0
8767-30	Inc. S_1 from popn-767	5.7	6.3
8767-44	Inc. S_1 from popn-767	6.0	6.3
8767-46	Inc. S_1 from popn-767	5.9	6.1
82-546	C546	5.9	5.8
83-718	C718	4.4	4.2
6762-17	C762-17	4.4	4.2
6827	C312	6.8	6.9
6830	C313	6.6	6.6
8790-92	C790-92	6.3	6.2
5796-43	C796-43	4.8	4.5
85-796-22	C796-22	3.7	3.8
5742-24	C742-24	5.1	5.0

TEST RZM 189-4. CBGA-BSDF RHIZOMANIA EVALUATION OF HYBRIDS, SALINAS, CA.,1989

24 entries x 10 reps., RCB — Planted: May 17, 1989

1-row plots, 16 ft. long — Harvested: October 30-31, 1989

Variety[1]	Description[1]	Acre Yield Sugar	Acre Yield Beets	Sucrose	RJAP	Clean Beets
		Lbs	Tons	%	%	%
Beta-4	Betaseed	5,531	19.71	13.98	82.7	82.6
R839 (C3)	Inc. R739C3	5,406	18.18	14.81	83.3	81.3
Rima	SES	5,212	17.16	15.15	81.6	81.8
Rizor	SES	4,918	17.25	14.21	79.7	80.9
Beta-2	Betaseed	4,838	16.54	14.65	82.4	80.9
87-1459-039	Holly	4,778	17.51	13.65	82.7	83.2
88-1459-074	Holly	4,671	18.25	12.80	80.7	80.5
Y846H102	7852MS x Y746	4,606	16.82	13.64	82.0	78.2
Rhizosen	L49302	4,538	17.49	12.95	82.0	80.5
88-C12-08	Holly	4,472	16.59	13.54	84.15	82.1
88-C13-06	Holly	4,279	17.09	12.45	83.0	86.9
R873H114	7224,5MS x R773	4,046	14.80	13.69	80.9	78.5
87-C40-04	Holly	4,021	15.52	12.89	84.3	81.1
R839H114	7224,5MS x R739C3	4,004	13.99	14.28	81.4	75.7
Beta-1	Betaseed	3,993	13.12	15.17	82.5	74.3
87-C35-04	Holly	3,751	14.26	13.12	83.3	80.8
Beta-5	Betaseed	3,577	14.65	12.17	81.9	74.5
Turbo	ACS- Maribo	3,439	12.13	14.14	81.7	80.7
RH34025M	Desprez	3,395	13.00	13.03	79.9	79.7
88-1459-073	Holly	3,381	13.81	12.08	79.6	73.4
H86178	Spreckels	3,167	12.04	13.15	81.4	75.4
Beta-3	Betaseed	3,103	11.70	13.16	81.5	72.2
Ritmo	ACS - Maribo	2,774	11.41	12.10	80.9	76.3
US H11	786442	1,447	7.26	9.99	75.5	62.2
MEAN		4,056	15.01	13.37	81.6	78.5
LSD (.05)		694	2.25	0.82	2.3	5.2
C.V. (%)		19.4	17.00	7.00	3.3	7.5
F value		14.1**	12.6**	15.5**	4.5**	7.0**

[1]R839C3 = C39R4. Y746 = C46/3. R773, 7852, 7224, 7225 segregates for R_Z.

Note: Grown under severe rhizomania conditions.

TEST RZM 389-1. RHIZOMANIA EVALUATION OF HYBRIDS, SALINAS, CA.,1989

28 entries x 6 reps., RCB
1-row plots, 13 ft. long

Planted: August 1, 1989
Harvested: November 20, 1989

Variety	Description[1]	Acre Yield		Sucrose	RJAP	Clean Beets
		Sugar Lbs	Beets Tons	%	%	%
Rizor	SES(1987)	1,626	7.30	11.10	71.9	83.6
Rima	SES(1989)	1,602	6.72	11.92	73.7	84.4
Rhizosen	Holly 49302	1,351	6.64	10.17	73.8	87.1
Y846H100	7850aa x Y746	1,337	6.43	10.42	76.3	87.6
Y846H105	7855aa x Y746	1,254	6.11	10.27	74.5	86.0
R839(C3)	Inc. R739C3	1,234	5.99	10.32	74.0	86.4
R839H114	7224,5aa x R739C3	1,208	5.77	10.47	71.7	81.3
R939HH	HRZCMS x R839C4	1,205	5.86	10.32	75.2	91.4
Y846H102	7852aa x Y746	1,172	5.94	9.92	74.3	89.1
R839H68	7767HO x R739C3	1,115	5.55	10.12	73.3	85.5
R847(C3)	Inc. R747C3	1,100	5.23	10.55	75.0	89.5
R873H114	7224,5aa x R773	1,089	5.05	10.77	78.1	85.4
Y846H104	7854aa x Y746	1,076	5.09	10.53	75.6	84.1
R873H115	7226aa x R773	1,070	5.22	10.33	75.1	83.5
R873H68	7767HO x R773	1,060	5.16	10.28	76.0	83.3
R873H116	7228aa x R773	1,057	4.85	10.83	75.9	83.7
8909H114	7224,5aa x 7909	1,053	5.15	10.22	74.1	85.4
R847H68	7767HO x R747C3	991	5.19	9.58	74.8	84.5
R873	Inc. R773 (C46/2R_Z)	974	4.63	10.52	72.6	91.3
Y846H106	7860aa x Y746	973	4.79	10.20	73.9	83.1

TEST RZM 389-1. RHIZOMANIA EVALUATION OF HYBRIDS, SALINAS, CA.,1989
(continued)

Variety	Description[1]	Acre Yield Sugar lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	Clean Beets %
Y846H117	7230aa x Y746	960	4.61	10.37	75.0	86.0
8909	7909aa x A	945	4.59	10.30	75.0	84.8
R839-6H68	7767HO x R739-6(C39R-6)	908	4.85	9.42	72.3	85.9
8909H68	7767HO x 7909	906	4.77	9.63	71.3	81.3
Y846H114	7224,5aa x Y746	679	3.52	9.68	76.0	85.4
Y846H68	7767HO x Y746	673	3.61	9.20	73.7	85.2
Y846	INC. Y764 (C46/2)	637	3.33	9.58	73.3	82.1
US H11	78442	456	2.70	8.48	68.9	71.2
MEAN		1,061	5.17	10.20	74.1	84.9
LSD (.05)		205	0.96	0.71	3.1	6.5
C.V. (%)		16.9	16.30	6.10	3.7	6.7
F value		12.6**	9.4**	6.4**	2.7**	2.5**

[1]HRZCMS = R_z CMS from Holly. 7767 = mm popn. 7909 = MMR_zpopn.
7850-7860 & 7224-7230 = mmR_zpopns.

TEST RZM 189-2. RHIZOMANIA EVALUATION OF LINES C0:C1:C2:C3:C4 SYNTHETICS OF Y39 & Y47
SALINAS, CA., 1989

24 entries x 4 reps., RCB
1-row plot, 16 ft., long

Planted: May 17, 1989
Harvested: November 1, 1989

Variety	Cycle	Description	Acre Yield Sugar Lbs	Gain %	Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Clean Beets %	Disease Index Rating
Y39 synthetics										
R839	C4	RZM R739 (C3)(C39R)	6,486	32	22.74	14.25	153	81.5	82.3	2.79
R839	C3	Inc. R739 (C3)	6,190	26	21.09	14.65	151	83.3	79.5	2.99
R739	C3	RZM R639 (C2)	5,952	21	21.16	14.05	140	82.4	82.4	2.81
R739	C2	Inc. R639 (C2)	4,905	0	17.84	13.60	156	82.8	84.5	3.19
R639	C1	Inc. R539 (1,1*)	4,695	- 5	16.35	14.40	150	81.8	77.4	3.13
Y439	C0	Inc. Y339	4,918	0	16.76	14.65	137	83.1	77.6	3.44
Y47 synthetics										
R847	C4	RZM R747 (C3)	5,875	103	21.73	13.50	154	83.8	79.7	2.99
R747	C3	RZM R647 (C2)	5,245	81	19.37	13.50	153	82.0	78.7	2.88
R847	C3	Inc. R747 (C2)	4,694	62	17.60	13.30	148	81.5	79.5	3.09
R647	C2	RZM R547 (C1)	4,842	67	17.96	13.45	153	82.1	83.9	3.05
Y547	C0	YR-ER-PMR Y347	2,892	0	12.14	11.93	118	81.1	78.6	3.70
Resistant Lines										
8906	--	RZM 7906,7aa x A	7,723	--	29.43	13.20	140	81.3	89.1	2.77
8911	--	RZM 7239 (A,aa)	6,168	--	20.88	14.75	129	82.7	79.6	2.97
R873	--	RZM R773 (C46R_Z)	5,680	--	19.71	14.38	143	82.2	88.3	2.93
R820	--	RZM R720 (FC)	5,220	--	20.56	12.68	139	81.2	80.1	3.10
R871	--	RZM R771 (C31R_Z)	5,063	--	17.94	14.05	151	80.9	87.0	3.01
R818	--	RZM R718 (Y54 x B.m.)	3,884	--	14.73	13.20	137	75.5	70.3	2.28
R824	--	RZM 7241,2(C37 x WB41)	3,784	--	13.42	14.10	150	78.6	69.5	3.38

TEST RZM 189-2. RHIZOMANIA EVALUATION OF LINES C0:C1:C2:C3:C4 SYNTHETICS OF Y39 & Y47
SALINAS, CA., 1989
(continued)

Variety	Cycle	Description	Acre Yield Sugar Lbs	Gain %	Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Clean Beets %	Disease Index Rating
Checks										
Rizor	--	SES	6,387	--	21.44	14.98	145	82.2	83.1	3.15
Rima	--	SES	6,365	--	20.35	15.60	129	81.1	83.1	3.08
Rhizosen	--	Holly	5,736	--	21.59	13.30	154	82.9	88.0	3.33
U86-37	--	Inc. C37	2,302	--	9.26	12.32	118	79.5	78.3	3.90
7903	--	6903aa x A	2,042	--	9.62	10.52	118	78.0	75.8	3.92
US H11	--	786442	1,568	--	7.28	10.80	129	78.2	77.0	4.28
MEAN			4,942	--	17.96	13.55	141	81.2	80.6	3.17
LSD (.05)			1,228	--	3.96	1.20	NS	3.3	9.6	0.32
C.V. (%)			17.6	--	15.60	6.30	14.3	2.9	8.5	7.20
F value			12.4**	--	12.6**	8.4**	1.4NS	2.8**	2.1**	14.2**

TEST RZM 289-2. RHIZOMANIA EVALUATION OF C0:C1:C2:C3:C4:C5 SYNTEHTICS OF Y39 & Y47
SALINAS, CA., 1989

16 entries x 8 reps., RCB
1-row plot, 16 ft., long

Planted: August 2, 1989
Harvested: November 29, 1989

Variety[2]	Cycle	Description[2]	Acre Yield Sugar Lbs	Gain[1] %	Beets Tons	Sucrose %	RJAP %	Clean Beets %
Y39 synthetics								
R939C5	C5	RZM R839C4	1,367	83	6.00	11.38	72.2	77.4
R839C4	C4	RZM R739(3),(C39R)	1,142	53	5.32	10.71	69.4	78.5
R739C3	C3	RZM R639	991	33	4.50	11.06	71.0	77.0
R739C2	C2	Inc. R639	990	33	4.57	10.82	69.8	77.9
R639	C1	Inc. R539(1,1*)	926	24	4.01	11.48	73.1	76.3
Y439	C0	Inc. Y339	746	0	3.54	10.59	68.9	68.0
Y939	--	YR-ER-PMR Y739(C39)	820	10	3.59	11.38	71.7	77.1
Y47 synthetics								
R9747C5	C5	RZM R847C4,(C47R)	1,261	116	5.53	11.39	72.0	78.8
R847	C4	RZM R747	1,109	90	5.03	11.04	71.7	79.3
R747	C3	RZM R647	1,050	80	4.70	11.15	71.8	77.6
R647	C2	RZM R547	984	69	4.56	10.73	71.9	77.5
Y547	C0	YR-ER-PMR Y347	583	0	3.03	9.52	67.9	73.0
Y947	--	YR-ER-PMR Y747(C47)	725	24	3.26	11.13	71.5	70.1
Checks								
Rizor	--	SES(1987)	1,289	--	5.65	11.40	70.1	75.5
Rhizosen	--	Holly 49302	1,101	--	5.40	10.19	71.0	76.2
US H11	--	786442	386	--	2.37	8.15	66.5	63.5
MEAN			967	--	4.44	10.76	70.7	75.2
LSD (.05)			174	--	0.73	0.59	3.0	6.5
C.V. (%)			18.2	--	16.70	5.50	4.3	8.7
F value			17.9**	--	16.2**	16.9**	2.7**	3.6**

[1]% gain relative to source; CO = Y439 for Y39; CO = Y547 for Y47.

TEST RZM 389-3. RHIZOMANIA EVALUATION OF C0:C1:C2:C3:C4:C5 SYNTEHTICS OF Y39 AND Y47
SALINAS, CA., 1989

16 entries x 6 reps., RCB
1-row plot, 13 ft., long

Planted: August 1, 1989
Harvested: November 30, 1989

Variety	Cycle	Description	Acre Yield Sugar Lbs	Gain[1] %	Beets Tons	Sucrose %	RJAP %	Clean Beets %
Y39 synthetics								
R939C5	C5	RZM R839C4	1,572	88	7.77	10.13	70.6	79.5
R839C4	C4	RZM R739(3),(C39R)	1,634	96	7.63	10.73	71.7	76.6
R739C3	C3	RZM R639	1,366	64	6.74	10.12	71.4	75.7
R739C2	C2	Inc. R639	1,236	48	6.29	9.77	70.8	83.0
R639	C1	Inc. R539(1,1*)	1,004	20	4.91	10.25	72.7	75.2
Y439	C0	Inc. Y339	834	0	4.49	9.18	66.5	70.5
Y939	--	YR-ER-PMR Y739,(C39)	816	- 2	4.07	10.00	75.1	73.9
Y47 synthetics								
R947C5	C5	RZM R847C4,(C47R)	1,579	142	7.63	10.28	70.6	76.9
R847	C4	RZM R747	1,421	117	7.06	9.98	77.7	78.5
R747	C3	RZM R647	1,415	116	7.09	9.95	72.9	83.0
R647	C2	RZM R547	1,384	112	6.76	10.25	73.8	77.8
Y547	C0	YR-ER-PMR Y347	653	0	3.64	8.98	73.0	66.4
Y947	--	YR-ER-PMR Y747,(C47)	867	33	4.49	9.63	70.6	71.7
Checks								
Rizor	--	SES(1987)	1,781	--	8.38	10.62	70.0	74.8
Rhizosen	--	Holly 49302	1,418	--	7.32	9.67	71.4	75.3
US H11	--	78442	540	--	3.67	7.37	67.9	61.0
MEAN			1,220	--	6.12	9.81	72.4	75.0
LSD (.05)			231	--	0.94	0.89	8.3	8.5
C.V. (%)			16.5	--	13.30	7.90	10.0	9.9
F value			21.5**	--	23.9**	6.3**	1.9*	3.5**

[1]% gain relative to source: C0 = Y439 for Y39; C0 = Y547 for Y47.

TEST RZM 289-1. RHIZOMANIA EVALUATION OF RESISTANT LINES, SALINAS, CA.,1989

16 entries x 8 reps., RCB
1-row plots, 16 ft. long

Planted: August 2, 1989
Harvested: November 29, 1989

Variety[1]	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	Clean Beets %
R939C5	RZM R839C4 (C39R)	1,339	5.95	11.21	72.4	81.9
R922(R)	RZM R722 (Y54 x B.m.)	1,328	6.85	9.69	67.3	72.8
R947C5	RZM R847C4 (C47R)	1,260	5.76	10.96	72.4	82.2
Rizor	SES(1987)	1,208	5.40	11.16	70.8	72.4
Rhizosen	Holly 49302	1,168	5.72	10.20	73.3	79.2
R978C2	RZM R878, C46/2R_z	1,157	4.96	11.66	73.2	76.5
R920	RZM R820 (C94)	1,142	5.66	10.07	70.1	74.6
N941	RZM 8205,6 (R_z x B883)	1,112	5.80	9.56	68.4	82.4
N911	RZM 8201,2 (R_z x B883)	1,105	5.91	9.35	69.6	87.4
9911	RZM 8911(A,aa), $R_z$popn	1,065	5.11	10.41	69.2	72.3
R980	RZM 8244, Y54R_z	1,029	4.52	11.39	72.2	81.6
R929C1	RZM 8229, (747aa x P107)	877	4.34	10.19	68.7	69.9
R928C1	RZM 8228, (C37 x P107)	786	3.98	9.95	70.6	61.9
Y854	Inc. Y654	553	2.87	9.61	70.4	65.4
86-46/2	Inc. C46/2	531	2.77	9.55	68.5	66.6
US H11	786442	409	2.63	7.84	62.8	59.4
MEAN		1,004	4.89	10.18	70.0	74.2
LSD (.05)		146	0.65	0.59	2.3	7.8
C.V. (%)		14.7	13.40	5.80	3.4	10.7
F value		31.0**	29.8**	21.2**	10.1**	8.3**

[1]R939C5 & R947C5 = 5th cycle selection for rhizomania resistance from Y39 & Y47.
R920 = resistant selection from Fort Collins & GW germplasm. R722 = C50 = Y54 x B.maritima
R928C1 = C28 = C37 x resistance from PI206407.

TEST RZM 389-2. RHIZOMANIA EVALUATION OF RESISTANT LINES, SALINAS, CA., 1989

32 entries x 6 reps., RCB
1-row plots, 13 ft. long

Planted: August 1, 1989
Harvested: November 21, 1989

Variety	Description[1]	Acre Yield		Sucrose	RJAP	Clean Beets
		Sugar Lbs	Beets Tons	%	%	%
R939C5	RZM R839C4, (C39R)	1,455	7.22	10.08	73.6	89.2
R978C2	RZM R878, (R_z isoline C46/2)	1,421	6.46	11.00	77.7	83.8
Rima	SES (1989)	1,389	6.40	10.88	73.0	83.1
8909	RZM 7909,(R_z isoline 9903x5747)	1,352	6.71	10.07	74.0	88.3
R913	RZM R813, (Salinas gp)	1,345	6.52	10.32	72.6	83.2
R947C5	RZM R847C4, (C47R)	1,321	6.57	10.05	75.2	85.9
R903	RZM R803, (Alba gp)	1,294	6.78	9.55	72.1	85.4
9910	RZM 8910, (R_z isoline 5747)	1,293	6.67	9.60	74.5	87.8
Rizor	SES (1987)	1,249	6.16	10.15	72.6	83.4
R980	RZM 8244, (R_z isoline Y854)	1,248	6.12	10.20	74.6	87.0
R920	RZM R820, (FC & CO gp)	1,230	6.64	9.25	72.0	84.9
R922(R)	RZM R722, (Y54 x B.maritima)	1,229	6.99	8.75	68.8	82.7
N911	RZM 8201,2,F_2(R78R_zxB883)	1,195	7.14	8.37	72.5	90.7
Rhizosen	Holly 49302	1,191	6.35	9.33	75.6	88.6
9911	RZM 8911, (R_z isoline 9903)	1,157	5.84	9.90	72.2	87.2
R939HH	Holly RZCMS x R839C4	1,142	6.31	9.03	74.2	89.4
R976	RZM R876, (R_z isoline C31/6)	1,108	6.13	9.02	75.2	87.6
R977	RZM R877, (R_z isoline C92)	1,082	5.49	9.75	72.5	83.9
N941	RZM 8205,6,F_2(909R_zxB883)	1,030	5.47	9,42	72.4	86.9
R904	RZM Rovigo Acc.	942	6.17	7.63	68.8	72.2

TEST RZM 389-2. RHIZOMANIA EVALUATION OF RESISTANT LINES, SALINAS, CA., 1989
(continued)

Variety	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	Clean Beets %
R929C1	RZM 8229, F_2(5747 x PI206407)	878	4.97	8.77	73.2	75.1
R928C1	RZM 8228, F_2(C37 x PI206407)	843	4.61	9.12	75.2	72.1
R921	RZM R821, (C37 x WB41 & WB42)	839	4.06	10.25	70.1	75.2
R918	RZM R818, (Y54 x B.maritima)	796	5.30	7.47	66.6	79.6
R979	Inc. R879, (R_Z isoline C37)	751	3.59	10.48	75.2	85.9
F86-31/6	Inc. C31/6	709	4.07	8.70	69.2	86.3
9903	YR-ER-PMR 7903(A,aa)	684	3.76	9.12	75.2	83.1
86-46/2	Inc. C46/2	660	3.52	9.40	74.2	80.0
86-92	Inc. C92	642	3.47	9.23	76.4	82.6
Y854	Inc. Y654	630	3.51	8.88	71.1	87.6
US H11	786442	507	3.28	7.62	70.9	74.3
86-37	Inc. C37	444	2.56	8.70	71.9	78.8
MEAN		1,033	5.46	9.38	72.9	83.5
LSD (.05)		208	0.97	0.68	3.6	7.0
C.V. (%)		17.7	15.50	6.40	4.4	7.4
F value		15.4**	15.7**	13.1**	3.5**	4.2**

[1]R939C5 & R947C5 = cycle 5 selection from Y39 & Y47.
R722 = C50. R928C1 = C28. R921 = C48.

TEST RZM 389-4. RHIZOMANIA EVALUATION OF LINES WITH RESISTANCE FROM B.MARITIMA
SALINAS, CA.,1989

12 entries x 6 reps., RCB
1-row plots, 13 ft. long

Planted: August 1, 1989
Harvested: November 30, 1989

Variety[1]	Description[1]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	RJAP %	Clean Beets %
R922(R)	RZM R722	1,471	8.38	8.80	64.8	67.8
R980	RZM 8244	1,459	6.82	10.70	73.8	73.5
R921(C48)	RZM R821	1,120	5.51	10.10	68.6	58.0
R918	RZM R818	1,001	6.82	7.33	63.4	63.1
R922(Y)	BYVR R722	995	5.74	8.70	65.9	68.4
R925	RZM R825	960	4.89	9.83	67.2	65.8
R924	RZM R824	874	4.61	9.45	67.6	57.7
R722(C50)	Inc. F1 & F2(Y54 x B.m.)	834	5.19	8.18	65.9	65.2
R922(S)	BYVR R722(%S)	817	5.15	7.98	66.7	72.2
Y854	Inc. Y654	748	4.07	9.17	67.9	70.3
U86-37	Inc. C37	487	2.96	8.22	65.0	63.3
5968	WB 51, Inc. 8968(1975)	170	1.26	6.75	45.5	45.7
MEAN		911	5.12	8.77	65.2	64.2
LSD (.05)		170	0.83	0.86	5.7	9.7
C.V. (%)		16.2	14.10	8.50	7.5	13.1
F value		36.3**	39.8**	14.5**	11.2**	5.0**

[1]5968 = WB51 = B.maritima from Denmark with resistance to rhizomania. R722(C50) = Y54 x B.maritima collection; Y922R = C1 RZM from R722; R922(Y) = C1 VYR from R722; R922(S) = C1 VYR & %S from R722. R918 = 3RZM(Y54 x B.m.). R921, R924, R925 = RZM (C37 x WB41 & WB42). R980 = R_Z iso-line of Y854.

TEST RZM 389-5. RHIZOMANIA EVALUATION OF RESISTANCE FROM PI206407, SALINAS, CA., 1989

8 entries x 6 reps., RCB
1-row plots, 13 ft. long

Planted: August 1, 1989
Harvested: November 30, 1989

Variety	Description[1]	Acre Yield		Sucrose	RJAP	Clean Beets
		Sugar Lbs	Beets Tons	%	%	%
9910	RZM 8910	1,467	8.36	8.78	67.6	76.0
R929C1	RZM 8229	1,321	7.41	8.85	68.3	72.7
R974	RZM R874	1,286	7.65	8.42	67.4	84.9
R928	Inc. 8228	1,224	7.30	8.35	67.4	62.1
R929	Inc. 8229	976	6.45	7.57	64.4	62.8
R928C1	RZM 8229	899	5.68	7.90	66.3	57.1
U86-37	Inc. C37	586	3.65	8.08	64.9	82.9
5747	4747aa x A	531	3.77	7.03	60.7	64.2
MEAN		1,037	6.28	8.12	65.9	70.3
LSD (.05)		222	1.13	0.70	3.1	5.8
C.V. (%)		18.3	15.30	7.30	4.1	7.1
F value		20.1**	20.5**	6.5**	5.1**	25.4**

[1]9910 = R_Z iso-line of 5747; R929 & R929C1 = 5747 x resistant plant from PI206407.
R974 = R_Z iso-line of C37; R928 & R928C1 = C37 x resistant plant from PI206407.

TEST RZM 289-3. PERFORMANCE OF LINES THAT COMBINE NEMATODE-RHIZOMANIA RESISTANCE
SALINAS, CA., 1989

16 entries x 4 reps., RCB
1-row plots, 16 ft. long

Planted: August 2, 1989
Harvested: November 30, 1989

Variety	Description[1]	Acre Yield		Sucrose	RJAP	Clean Beets
		Sugar Lbs	Beets Tons	%	%	%
R978C2	RZM R878	1,459	6.27	11.65	76.3	72.7
N902-3H46	8906aa x 8203,4,5	1,440	7.44	9.65	71.7	72.9
Rhisozen	Holly 49302	1,338	6.64	10.07	71.3	72.8
N911	NR-RZM 8201,2	1,224	6.89	8.90	70.9	84.3
N941	NR-RZM 8205,6	1,222	6.42	9.50	71.8	81.4
N902-5H45	8909aa x 8204,6	1,208	6.18	9.80	72.5	68.9
N971	NR-RZM 8209,10	1,186	6.30	9.38	69.8	72.4
9911	RZM 8911	1,176	5.61	10.43	71.1	69.5
N902-1H115	8857aa x 8201,2	1,077	5.32	10.13	70.3	67.9
9857	RZM 8857	984	4.74	10.35	72.3	70.6
N902-1	Inc. 8201,2	792	4.30	9.15	67.3	68.5
N902-5	Inc. 8205,6	733	3.82	9.57	68.9	70.3
N801H(B)	CMS x B883 (Blend)	595	4.16	7.05	60.9	63.4
86-46/2	Inc. C46/2	583	3.13	9.35	69.4	54.8
US H11	786442	404	2.70	7.53	62.6	56.8
N801 A	Inc. B883	102	1.01	5.20	52.4	60.8
MEAN		970	5.06	9.23	68.7	69.2
LSD (.05)		305	1.33	1.05	5.9	11.5
C.V. (%)		22.1	18.40	8.00	6.0	11.7
F value		13.5**	14.4**	17.2**	7.7**	3.6**

[1]Cyst nematode resistance from B883. B883 = NR line from I.R.S.,Bergen op Zoom, the Netherlands. Resistance from Beta procumbens. NR-RZM = selected for resistance in 1988 for resistance to cyst nematode and rhizomania. R878 = C46/2R_Z. 8857 = popn-767R_Z. 8906 & 8911 = MM,S^f, A:aa R_Z populations. 8201,...,8210 = F_1(R_Z x B883).

TEST RZM 189-1. 1989 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1989

64 entries[8] x 3 reps, RCB
1-row plots, 10 ft., long

Planted: May 15, 1989
Natural infection to BWYV
Harvested: October 13, 1989

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 10/10	#61 BWYV[6] DI	#74 Rhizomania[7] DI	#74 Rhizomania[7] %H
PI 105335	China	42	3	3	3	6	2	3.3	3.3	6.4	0.0
PI 171508	Turkey	48	5	1	3	1	2	5.0	4.5	5.3	8.3
PI 171515	Turkey	38	5	1	2	1	2	5.0	4.3	6.0	2.6
PI 171516	Turkey	32	5	1	2	1	2	4.0	4.3	6.6	0.0
PI 171518	Turkey	33	5	1	2	1	2	5.3	5.0	6.8	0.0
PI 171519	Turkey	29	5	1	2	4	2	4.3	3.5	6.6	3.5
PI 172729	Turkey	38	3	3	3	4	2	3.0	2.7	6.0	7.9
PI 172731	Turkey	1	8	3	3	4	3	---	---	9.0	0.0
PI 172733	Turkey	16	3	3	3	4	3	5.0	4.0	6.1	0.0
PI 173844	India	42	3	3	3	4	2	3.3	3.2	6.7	0.0
PI 175594	Turkey	43	5	2	3	4	2	5.3	5.2	6.8	4.7
PI 176423	Turkey	35	5	1	2	1	2	4.3	3.8	7.1	0.0
PI 177274	Syria	49	3	3	3	4	2	4.3	4.3	6.4	0.0
PI 178836	Turkey	42	3	3	3	4	2	4.3	4.2	7.0	0.0
PI 178837	Turkey	37	3	3	3	4	2	4.7	4.3	6.7	0.0
PI 179173	Turkey	37	5	1	2	1	2	4.7	4.5	6.1	0.0
PI 179180	Turkey	47	3	3	3	4	3	3.3	3.5	6.5	0.0
PI 180409	India	0	8	1	3	6	1	---	---	---	---
PI 181717	Lebanon	44	3	3	4	4	1	3.0	3.0	6.6	0.0
PI 218063	Pakistan	0	8	1	3	6	1	---	---	---	---

TEST RZM 189-1. 1989 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1989

(continued)

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 10/10	#61 BWYV[6] DI	#74 Rhizomania[7] DI	#74 Rhizomania[7] %H
PI 220508	Afghanist	49	5	1	2	1	2	4.0	4.0	6.6	2.0
PI 224684	Burma	45	3	3	3	4	2	3.3	3.5	6.5	2.2
PI 229589	Iran	10	7	3	3	6	3	3.3	3.5	6.8	0.0
PI 232892	Hungary	42	3	3	3	4	2	4.0	4.2	6.7	2.4
PI 232893	Hungary	51	5	1	2	1	2	4.3	4.3	6.3	9.8
PI 232894	Hungary	43	5	1	2	1	2	3.7	3.7	7.0	0.0
PI 251042	Yugoslav	61	5	1	3	1	2	4.0	4.0	6.6	0.0
PI 256053	Afganist	24	3	2	3	4	3	5.7	5.2	7.6	0.0
PI 274392	Poland	48	5	1	2	1	2	4.7	4.7	6.3	2.1
PI 274393	Poland	53	5	1	2	1	2	4.3	4.0	6.1	9.4
PI 274395	Poland	42	5	1	2	1	2	3.7	3.2	6.3	4.8
PI 293419	USSR	43	2	1	4	3	2	3.0	3.0	6.5	0.0
PI 344063	Turkey	1	5	2	2	1					
PI 344064	Turkey	37	5	2	2	1	3	3.7	3.7	6.2	5.4
PI 355959	USSR	56	5	1	2	1	2	3.7	3.5	6.6	5.4
PI 355960	USSR	46	5	1	2	1	2	3.3	3.0	6.2	4.4
PI 355965	USSR	51	5	1	2	1	2	3.0	3.0	6.3	5.9
PI 355966	USSR	51	5	1	3	4	2	2.7	2.5	6.4	5.9
PI 357353	Yogoslav	47	3	3	3	4	2	3.0	3.0	7.1	0.0
PI 357356	Yugoslav	46	2	1	4	3	2	2.0	2.3	6.5	0.0
PI 357359	Yugoslav	2	3	1	2	1	3	---	---	4.0	50.0
PI 347362	Yugoslav	3	7	1	2	1	3	---	---	7.7	0.0
PI 357363	Yugoslav	42	3	1	2	1	2	4.3	4.2	6.5	0.0
PI 357364	Yugoslav	40	5	2	2	1	3	3.3	3.3	6.5	5.0
PI 357365	Yugoslav	5	1	2	2	1	3	6.0	5.0	6.2	0.0

TEST RZM 189-1. 1989 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1989

(continued)

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 10/10	#61 DI	#74 Rhizomania[7] DI	#74 Rhizomania[7] %H
PI 379098	Yugoslav	1	8	2	3	6	3	---	---	7.0	0.0
PI 452435	China	52	5	1	2	1	2	3.7	3.5	6.4	7.7
PI 470089	Germany	52	5	1	2	1	2	3.7	3.5	6.3	9.6
Ames 2661	USA-Ut	37	5	1	2	1	2	3.0	2.5	5.7	5.4
Ames 2666	USA-Ut	43	5	1	2	1	2	3.3	3.5	6.0	9.3
Ames 3039	USA-Ca	41	5	1	2	4	2	3.3	3.7	6.4	2.4
Ames 3040	USA-Ca	59	5	1	2	1	2	3.3	3.2	5.9	6.8
Ames 3041	USA-Ca	27	5	1	2	4	2	3.7	3.5	6.3	0.0
Ames 3042	USA-Ca	59	5	1	2	4	2	4.0	3.8	5.6	8.5
Ames 3043	USA-Ca	1	8	1	2	1	1	---	---	5.0	0.0
Ames 3044	USA-Ca	42	5	1	2	1	3	3.3	2.8	6.4	0.0
Ames 3045	USA-Ca	53	5	1	2	1	2	3.0	2.5	6.1	7.6
Ames 3047	USA-Ca	47	5	1	3	4	2	2.3	2.3	6.6	2.1
Ames 3049	USA-Ca	58	5	1	2	1	2	2.3	2.3	6.3	3.5
Ames 3051	USA-Ca	54	5	1	2	4	2	3.3	3.0	6.7	3.7
Checks											
US H11		57	5	1	2	1	2	3.7	3.2	6.2	0.0
R839	C39R	57	5	1	2	1	2	2.0	1.7	2.8	73.7
R873	R_Z-C46	53	5	1	2	1	2	3.3	2.7	4.6	37.7
Rima	SES-hy	59	5	1	2	1	2	4.3	4.2	3.7	49.2

TEST RZM 189-1. 1989 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1989

(continued)

[1] #1 End use based upon field plot appearance where: 1=chard; 2=DDR-like; 3=DDR, chard, spinach; 4=fodder; 5=sugar; 7=mixed, 8=annual.

[2] #5 Population Uniformity: 1=all plants alike; 2=uneven different types; 3=mixed, green, red, yellow, high, low, large leaves, small leaves, etc.

[3] #12 Mature Leaf Blade Pigmentation: 1=light green (chard), 2=green, 3=red & green, 4=red, 5=yellow.

[4] #19 Petiole Color: 1=green, 2=pink, 3=red, 4=candy stripe, 9=yellow, 6=mixed.

[5] #37 Bolting Tendency without cold induction: 1=B-(annual)=100%, 2=bb(biennial)-0%, 3=B:bb(mixed) 1-99%.

[6] #61 Beet Western Yellows (BWYV): 0=immune; 1=very resistant; 3=resistant; 5=intermediate; 7=susceptible; 9=highly susceptible based upon yellowing of leaves. Mean disease ratings (DI) from Sept. 21, and Oct. 10, 1989. 10/10=final rating.

[7] #74 Rhizomania: DI-disease index based upon 0=no visual symptoms; 1=very minor root symptoms; 3=normal tap root, slight bearding; 5=wine-glass shaped, bearded, moderate damage; 7=severly damaged, loss of tap root; 9=dead due to rhizomania %Healthy=classes (0+1+2+3)/total.

[8] 64 entries = 60 PI lines from Ames plus checks. Checks are: US H11=highly susc. to rhizomania, mod. resistant to BWYV; C39=moderately resistant to BWYV and rhizomania; R873=mod. resistant to BWYV and rhizomania; Rima=commercial hybrid mod. resistant to rhizomania and susceptible to virus yellows.

Conclusion: No types were found with BWYV resistance as good as C39 check. No individual plants were observed with high resistance or immunity to BWYV. Variability occurred for reaction to rhizomania but no line was as resistant as C39R; no individual plants within lines were observed that had resistance to rhizomania. For BWYV and rhizomania, no individual plants or lines were selected for reevaluation and/or incorporation into the breeding program at Salinas.

SUGARBEET RESEARCH

1989 Report

Section B

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Agricultural Research Service
United States Department of Agriculture
Beltsville, Maryland

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CONTENTS

DEVELOPMENT OF GENE-TRANSFER TECHNOLOGY FOR SUGARBEET

Lowell D. Owens

We continue to conduct parallel research on the two aspects of this technology; (i) tissue culture -- with emphasis on increasing the production of somatic embryos or shoots that are potentially transgenic, and (ii) gene transfer -- with emphasis on increasing the frequency of gene transfer to sugarbeet cells using Agrobacterium vector systems. Additional effort is directed to constructing a useful gene to be inserted into sugarbeet once the technology is developed.

Tissue Culture -- L. D. Owens and C. Wozniak

During studies to optimize the production of regenerable callus from cultured leaf discs (line REL-1) we compared their performance on five different gelling agents and observed large differences associated with the particular gel. Upon analyzing the source of these differences we discovered that the water potential of the gel was a major determining factor. A simple method was devised to compare the water potentials of various gels at different gel concentrations. By this method, a nearly saturated filter paper disc is placed on the gel surface, allowed to equilibrate for 20 hours, and then removed and weighed. The relative gain or loss of water from the disk is a measure of the water potential of the gel and is a function of both gel type and concentration. Water availability to cultured leaf discs is also affected by the ability of the expanding and contorting disc to locally compress the gel causing the expression of free water. Water expressibility was measured by using a weight and capillary pipette and found also to be a function of gel type and concentration. By optimizing water availability, more than 200 callus-derived embryos and shoots were produced in a single dish of cultured sugarbeet leaf discs.

Gene transfer -- C. Wozniak and L. D. Owens

Generally, in gene-transfer experiments it is common to include in the transferred DNA segment a "reporter" gene to indicate within a few days whether the transfer was successful. The most convenient and widely used reporter gene is B-glucuronidase (GUS), from the uidA locus of Escherichis coli, placed under control of plant regulatory DNA sequences. B-glucuronidase activity has generally been considered to be absent from higher plants. During an analysis of Agrobacterium-mediated transformation of sugarbeet, however, significant activities were observed in control (non-transformed) tissues when the florogenic substrates 4-methylumbelliferyl-B-D-glucuronide (MUG), resorufin glucuronide and 3-carboxyumbelliferyl-B-D-glucuronide were used to quantify GUS. Similarly, the colorigenic substrate p-nitophenyl-B-D-glucuronide was hydrolyzed by this sugarbeet-derived glucuronidase. We have characterized this activity biochemically and found significant differences between sugarbeet-GUS and GUS of microbial origin. These differences provide a means of distinguishing between the two enzyme activities and enabled us to develop a quantitative assay for

reporter GUS in extracts that also contain sugarbeet-GUS. X-gluc, the substrate utilized in histochemical localizations of GUS activity, was not recognized by sugarbeet-GUS; hence, the use of this substract in identifying sugarbeet cells transformed with the uidA coding sequence is an acceptable approach. These findings enable us to use accurately either the quantitative or the histochemical assay for GUS encoded by the reporter gene in transgenic sugarbeet cells.

We have used the leaf-disc infection technique in conjunction with Agrobacterium tumefaciens strain 281(pBI121) to infect nine genotypes of sugarbeet. GUS-positive callus was obtained from three of these genotypes indicating successful gene transfer. The GUS-positive calli also display kanamycin resistance as a result of cointroduction of a selectable marker gene. Regeneration of these transgenic calli is being attempted.

Resistance gene construction -- R. Nordeen and L. Owens

A gene encoding a polypeptide that is bactericidal to a number of plant pathogenic bacteria has been modified by joining the coding region of the mature peptide to a plant DNA sequence encoding a signal peptide. The purpose of the signal peptide is to target the lytic peptide out of the cytoplasm where it may be toxic to mitochondria and chloroplasts. The resulting chimeric gene will be cloned into an Agrobacterium vector plasmid and used in gene-transfer experiments with the goal of controlling root rot in sugarbeet.

SUGARBEET RESEARCH

1989 REPORT

Section C

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CONTENTS

Publications

Abstracts of Papers Presented, Published, or Approved for Publication.

Hecker, R. J. and M. McClintock. 1989. Sugarbeet pollen viability indicators. J. Sugar Beet Res. 26:40-48.

Ten fluorochromes and seven stains were evaluated as indicators of viability of sugarbeet (*Beta vulgaris*) pollen. The reactions of these materials were compared with in vitro germination of pollen in a liquid medium. Among these 17 materials, fluorescein diacetate (FDA); 3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyl-2H-tetrazolium bromide (MTT); and isatin exhibited viability reactions that were positively related to in vitro pollen germination. However, only the FDA fluorescence reaction was related consistently to germination in all pollen sources. The linear regression model of germination (Y) and FDA reaction (X) was Y = 0.6X - 12. The fluorochromes 4',6-diamidino-2-phenylindole (DAPI); ethidium bromide; and aniline blue exhibited some potential to detect and display the presence of DNA, sperm cells, and in vivo pollen tubes, respectively.

Hecker, R. J. and M. E. McClintock. 1989. Pollen as a tissue for assay and selection in sugarbeet. J. Sugar Beet Res. 26(1):A10.

Pollen is a tissue that needs to be tested for potential genetic assay and selection in vitro. We used sugarbeet pollen as an assay tissue by exposing pollen to commercially produced enzymes known to be elicited in vivo by *Rhizoctonia solani*. Pectinase, pectolyase, and cellulase each enhanced in vitro germination of pollen from Rhizoctonia rot root susceptible plants compared with pollen from resistant plants. Pollen tube growth rates and tube lengths were not different. There was less ion leakage from pollen of susceptible plants than from pollen of resistant plants into media augmented with low concentrations of pectolyase, as measured by conductivity. When measured by inductively coupled plasma spectroscope (ICP), these same differences were observed for leakage of potassium and magnesium ions. In the case of pectinase, there was more potassium leakage from resistant pollen as measured by ICP, as well as by emission spectroscopy. The discriminatory power of these tests for resistance is not resolved completely at this time. Selection in sugarbeet pollen was attempted for cold tolerance (4 cycles) and salt tolerance (1 cycle). We have some evidence that low temperature challenge of the gametophyte resulted in faster emergence of progeny seedlings in 10C soil. One cycle of salinity challenge of pollen is being evaluated for change of salinity tolerance of the resultant progeny.

Martin, S. S. The phytoalexin response of diverse *Beta* lines infected by *Cercospora beticola*. J. Sugar Beet Res. 26(1):A16.

The flavonoid phytoalexins **betagarin** (B) and **betavulgarin** (BV) accumulate in sugarbeet, *Beta vulgaris* L., in response to infection by *Cercospora beticola* Sacc. HPLC (C-18 column, 4.6 mm x 25 cm; gradient elution with mixtures of acetonitrile and 3% aq. acetic acid; UV detection) was used to determine the presence and concentrations of these compounds in ether extracts of leaf lesions. B and BV were identified by their ultraviolet spectra, obtained on-line from the photodiode array HPLC detector. Lesions were sampled from fifteen diverse *Beta*

lines, field-grown and inoculated with *C. beticola*. These USDA Plant Introduction lines were collected in countries around the world. BV accumulated in lesions of each of the lines examined, which included the conspecific but phenotypically distinct chard, red and yellow table beet, fodder beet, annual beet, and the presumed ancestral *Beta maritima*. B was present in most lines, but was below detectable limits in a few cases. The generality of the phytoalexin response in these diverse genotypes supports the hypothesis that these compounds are involved in resistance to the pathogen. B and BV also were elicited in sugarbeet leaf blades and petioles by several abiotic agents; thus, in addition to their classification as phytoalexins, B and BV are included in the more general class of "stress metabolites."

Martin, S. S. 1989. Elicitation of flavonoid stress metabolites of *Beta vulgaris*. Amer. J. Bot. 76(6) Suppl.:194.

The flavanone **betagarin** (B) and the isoflavone **betavulgarin** (BV) are phytoalexins induced in sugarbeet, *Beta vulgaris* L., upon infection by the fungus *Cercospora beticola* Sacc. The ability of several other biotic and abiotic treatments to elicit the production of these compounds was examined. Droplets (10 μl) of the potential elicitor in aqueous solution were applied to sugarbeet leaf laminae or petioles and incubated at 23C for various times. Elicitor droplets and underlying tissue were extracted by sonication with diethyl ether (15 m). B and BV were separated and quantitatively determined by HPLC (C-18 reverse phase column, 4.6 mm x 25 cm; gradient elution with mixtures of acetonitrile and 3% aq. HOAc; photodiode array detection). UV spectra (200-360 nm) were examined to confirm compound identity. B and BV were elicited by ultraviolet light, heavy metal solutions, and spore suspensions of three distinctive *C. beticola* isolates; they also were found in field-grown, *Rhizoctonia solani*-infected sugarbeet roots. Thus, B and BV, in addition to their classification as phytoalexins, may be more generally classed as "stress metabolites."

Martin, S. S. and C. E. Townsend. 1989. Isoflavan stress metabolites in North American cultivars of *Astragalus cicer*. Amer. J. Bot. 76(6) Suppl.:194.

Astragalus cicer L., "cicer milkvetch," is native to Eurasia but has been developed in the United States and Canada as a forage legume. Many animal feeding trials with cicer milkvetch have shown good results, but in a few cases the test animals suffered mild to severe photosensitization reactions. Tests for several classes of potentially toxic phytochemicals were negative. Because isoflavonoids have been implicated as potential phytosensitizing agents, we examined several U.S.- and Canadian-developed cicer milkvetch cultivars for their production of two isoflavan phytoalexins, **astraciceran** and **mucronulatol**, previously described (Ingham and Dewick, Phytochem. 19:1767-1770, 1980) from a European source of cicer milkvetch. Spore suspensions (5 x 10^4 spores/ml in 0.005% Tween 20) of *Helminthosporium carbonum* Ullstrup were applied as 10 μl droplets to detached leaflets of *A. cicer*; controls were Tween 20-containing distilled water. Leaflets (on moist filter paper in 15-cm petri dishes) were incubated in the light for 48 hr at 23C. Ethyl acetate extracts of the droplet diffusates were examined by HPLC (C-18 column, gradient elution with acetonitrile-3% HOAc mixtures, diode array UV detection). In addition to astraciceran and mucronulatol, several other flavonoids were elicted, with quantitative differences among cultivars. The herbicide 2,4-D (amine salts) also elicited isoflavonoid stress metabolites.

Narum, J. A. and S. S. Martin. 1989. Impurities and sucrose in the root, peel, and interior of diverse sugarbeet lines. J. Sugar Beet Res. 26(1):A18-A19.

Quantities of selected impurities in the near-surface layers ("peel") of the sugarbeet were compared with those of the root interior (the peeled beet) and the whole root. Amino-N (ninhydrin), sodium and potassium (flame photometer), percent sucrose (polarimeter), and dry weight were determined. To explore the range of these characters in beets of varied genetic backgrounds, we examined 10 diverse sugarbeet types, including commercial sugarbeets, smooth-root types, other experimental inbred lines, and a sugarbeet-fodder beet hybrid. In general, peels contained significantly higher concentrations of impurities and lower concentrations of sucrose than did either the whole root or the interior; significant differences existed among cultivars. Ultimately, these data will be useful, together with those of others, in assessing the feasibility of improvement in beet processing quality by peel removal.

Ruppel, E. G. 1989. Selecting for alkaline tolerance in *Trichoderma harzianum*. Phytopathology 79:1160.

Trichoderma spp. are favored by moist, acid soils but do persist in western calcareous soils at low population densities, which may indicate genetic diversity for alkaline tolerance. Selections from over 200 random isolates of *Trichoderma* spp. were made in vitro at increasing medium pH. One isolate of *T. harzianum* (TpH) grew and sporulated on pH 11 medium. At soil pH 6.7 with six consecutive plantings, TpH and a known biocontrol isolate of *Rhizoctonia solani* (THW) at 10^6 colony-forming units/g significantly suppressed sugarbeet damping-off by *R. solani* in the first two plantings. By the sixth planting, treatment effects were nonsignificant. In soil at pH 8.2 with three plantings, no significant damping-off suppression occurred at planting 1, but both isolates suppressed disease at plantings 2 and 3. At pH 6.7, TpH was not as effective as THW in increasing seedling survival, and was no more effective than THW at pH 8.2.

Ruppel, E. G. Sugar Beet. In: Plant Pathology. R. T. Plumb, ed. MacMillan/Intercept Publishers, London. (In press) [Chapter on sugarbeet diseases for a three-volume plant pathology reference publication.]

Papers Published Since Abstracted in Previous Report

SMITH, G. A. and S. S. MARTIN. 1989. Effects of selection for sugarbeet purity components on quality and sucrose extractions. Crop Sci. 29:294-298.

MARTIN, S. S. 1989. Analysis of constitutive and induced phenolics of *Beta vulgaris* by high performance liquid chromatography. J. Sugar Beet Res. 26:A16 and 26:33-39.

EFFECT OF ROOT SIZE ON COMBINING ABILITY FOR SUCROSE PRODUCTION (BSDF Project 200)

R. J. Hecker

This is the final report on this project. The objective of the project was to determine how root size affects combining ability (CA) for root yield and sucrose. This is important and necessary information for sugarbeet breeders.

Our method of studying the CA-root size relationship was to select for root size in a heterogeneous population, but hold sucrose content constant. Then we crossed the large root, small root, and source populations onto a common set of CMSs for CA comparisons in 2 years of field tests at Ft. Collins. Specific and general combining ability (SCA and GCA) effects were partitioned for the three pollinators.

Our starting population was GW674, a heterogeneous, multigerm, open-pollinated cultivar (obsolete) adapted to the irrigated plains. About 30 large and 30 small (minimum 6-cm-diameter) roots were selected from about 300 plants within each of 10 small blocks grown at optimum fertility at the Colorado State University Agronomy Research Center, for a total of 300 large and 300 small selections. From these large and small roots, about 50 roots were selected for sucrose content in each group. The 50 large roots had to be more than one standard deviation heavier than the mean of GW674, and the 50 small roots were more than one standard deviation lighter than the GW674 mean. Further, the sucrose content of each root in both groups had to be less than one-half standard deviation from the GW674 mean, and the mean of the 50 large and 50 small roots had to be the same as that of GW674. This control of sucrose was necessary to prevent a confounding effect of sucrose on CA for root size. These 50 large and 50 small roots were interpollinated in separate isolations, and the seed was harvested in bulk. This seed was planted in two blocked selection strips for three more cycles of selection similar to the first cycle. In each cycle, the final 50 large and 50 small selections had to have the same sucrose mean as GW674. In the 4th cycle isolation plots, five diverse CMSs (three single-cross hybrids and two inbreds) were interplanted and harvested separately as combining ability testers. In the same year, a random sample of GW674 roots was used as the pollinator of the same five CMS testers.

In 1988 and 1989, the 15 top-cross hybrids (5 CMSs x 3 pollinators) were grown in field tests at Ft. Collins, along with GW674 and the 4th cycle large and small root selections. The experimental design was a randomized complete block with six replications of 1-row plots, 20 ft long and 22 inches apart. The experiments were planted 4/14/88 and 4/18/89 and were harvested 10/6/88 and 10/6/89. Standard plot weight, sucrose, and thin juice purity determinations were made. Amino N, sodium, and potassium were analyzed in pressed juice in 1988 and in sucrose filtrate in 1989.

In Table 1 are shown the means for 1988 and 1989 combined. Four cycles of mass selection for root size did succeed in separating the two populations for root size, but resulted in no significant difference for sucrose, purity, or recoverable sucrose.

Table 1. Means (1988 and 1989) for 4th cycle small root selection, 4th cycle large root selection, and GW674.

Population	kg/plot	% Sucrose	% Purity	kg/plot
4th cycle small root	15.7b[1]	15.2a[1]	92.4a[1]	5.97a[1]
4th cycle large root	17.6a	14.8a	91.7a	6.31a
GW674 (source)	16.3ab	15.1a	92.4a	6.13a

[1] Means within columns followed by the same letter are not significantly different ($P = 0.05$)

The chemical characters, which cannot be combined over years, are in Table 2.

Table 2. Means of amino N, Na, and K in 1988 pressed juice and 1989 sucrose filtrate.

	1988			1989		
Population	AMN	Na	K	AMN	Na	K
	(mg/100 ml)			(mg/100 ml)		
4th cycle small root	57a	28ab	155a	7.0a	3.3a	21.5a
4th cycle large root	35b	36a	138a	5.2b	4.2a	18.0b
GW674 (source)	60a	22b	150a	6.5ab	4.1a	21.3a

The 15 hybrids in the 1988 and 1989 experiments were analyzed as a subset. The means of the individual hybrids and the hybrids grouped by pollinator are in Table 3. The only significant differences among the means of the three hybrid groups were for sucrose content, where hybrids with the 4th cycle small-root pollinator had higher average sucrose than the set with the large-root pollinator. No significant differences occurred for hybrid sets for root yield, purity, or recoverable sucrose.

Table 3. Means[1] for yield and quality characters of 15 hybrids and groups with common pollinators.

Hybrid or group		Root wt. (kg/plot)	Sucrose (%)	Purity (%)	Recov. sucrose (kg/plot)
52-305CMS X	4th cy. large root	15.8BC	14.4EF	92.5	5.66CDE
SP73747-01 CMS X	" " " "	16.2AB	14.2F	92.6	5.87BCD
(FC506CMS X L36) X	" " " "	17.9AB	14.6DEF	92.8	6.53ABC
(FC604CMS X Polish OT)	" " " "	17.0AB	14.6DEF	92.6	6.17ABCD
(SLC129CMS X SLC133)	" " " "	18.0AB	14.8CDEF	92.6	6.63AB
Means of hybrids with	" " " "	17.0a	14.5c	92.6	6.17a

Table 3. (continued)

Hybrid or group		Root wt. (kg/plot)	Sucrose (%)	Purity (%)	Recov. sucrose (kg/plot)
52-305CMS X	4th cy. small root	13.7CD	16.0A	91.5	5.36DE
SP73747-01 CMS X	" " " "	16.9AB	15.3BCD	91.2	6.25ABCD
(FC506CMS X L36) X	" " " "	17.6AB	15.1BCD	91.8	6.34ABC
(FC604CMS X Polish OT) X	" " " "	18.4A	15.4ABC	92.0	6.93A
(SLC129CMS X SLC133) X	" " " "	15.8BC	15.7AB	92.4	6.21ABCD
Means of hybrids with	" " " "	16.5a	15.5a	91.8	6.22a
52-305CMS X	GW674	13.3D	15.5ABC	90.5	4.89E
SP73747-01 CMS X	"	18.4A	14.8CDEF	92.0	6.65AB
(FC506CMS X L36) X	"	17.0AB	15.0CDE	92.7	6.39ABC
(FC604CMS X Polish OT) X	"	16.4AB	15.2BCD	93.0	6.21ABCD
(SLC129CMS X SLC133) X	"	16.3AB	15.2BCD	92.8	6.13ABCD
Means of hybrids with	"	16.3a	15.1b	92.2	6.05a

[1] Means within columns followed by the same upper case letter are not significantly different ($P = 0.05$); likewise for lower case letters. No letters indicates no significant differences among entries or set means.

The analyses of variance for GCA and SCA are detailed in Table 4. Root weight and sucrose are the important characters. GCA effect of pollinators was not significant for root yield, indicating that GCA for root yield was unaffected by root size among these large- and small-root populations. Hence, when other characters were held outwardly constant, root size of the pollinator had no significant influence on root yield of its hybrids. The significant effect of our set of females on GCA indicates that GCA is important in females for effect on root yield in hybrids. We would expect a random set of males also to have significant GCA effects, but that was not the case where our males differed only for root size.

Table 4. Analyses of variance for general and specific combining ability (GCA and SCA) for yield and quality characters.[1]

Source of variation	df	Root wt. (kg/plot)	Sucrose (%)	Purity (%)	Recov. sucrose (kg/plot)
GCA pollinators	2	NS	**	NS	NS
GCA females	4	**	*	NS	**
SCA female X male	8	*	NS	NS	NS

[1] *, ** = significant effect of $P = 0.05$ and 0.01, respectively; NS = not significant.

The significant SCA effect for root yield indicates that our three males combined differently with some of the females. Examination of the means in Table 3 reveals that some of the SCA variance was contributed by GW674, but considerable variance was contributed by hybrids with the small-root male. Surprisingly, little of the SCA variance was apparently due to hybrids with the large-root male. It is not appropriate to extrapolate from our two selected sets to sugarbeets in general, but it is logical to propose that our selection for large root assembled more genes with additive effects than did small root selection.

This is supported by the analysis in Table 5, where the 14 degrees of freedom for root yield of hybrids was partitioned into effects of individual males. This table shows significant variance was due to hybrids of small root males and GW674 (the unselected source), but not due to hybrids of large root males. Another possibility is that our small root selection discriminated against additive genes for root size. However, it is not likely that our selections had any direct effect on nonadditive genes, because, in theory, mass selection should not have an effect on genes for nonadditive effects.

Table 5. Partition of variation due to combining-ability effects into male effects and female effects within individual males.[1]

Source of variation	df	Root wt. (kg/plot)	Sucrose (%)	Purity (%)	Recov. suc. (kg/plot)
GCA pollinators	2	NS	**	NS	NS
4th cy. small root X females	4	*	*	NS	*
4th cy. large root X females	4	NS	NS	NS	NS
GW674 X females	4	**	NS	NS	**

[1] *, ** = significant effect of $P = 0.05$ and 0.01, respectively; NS = not significant.

Examination of the results for sucrose content in Tables 3, 4, and 5 complicate the interpretation. In Table 1, the sucrose content of large- and small-root populations was 14.8 and 15.2%, respectively, not sufficiently different to be significant but tending in the expected directions. The hybrids in Table 3 show significant pollinator differences. The partition of variance for sucrose in Table 4 confirms these differences of the means. GCA effects of males and females are significant, but SCA effects are not. The repartition of the variance in Table 5, shows that GCA effect and variance due to hybrids of the small-root male are the only significant variance contributors. These results imply that genes with additive effects for sucrose were accumulated in the small-root selection, even though avoidance was attempted. Also, these genes had more effect on hybrid progeny than in the small-root population per se.

Interpretation is further complicated by the fact that these effects on sucrose and root yield surely are not independent. It seems explicable and logical from these data that sucrose is conditioned primarily by additive genes, as measured by GCA effects, whereas root yield is conditioned by both additive and nonadditive effects when root size is random or small. It seems likely that cell size is also implicated in these results. If so, it can be interpreted from these data that small cell size may be less fixed, hence, interact more with random females and have more potential for SCA differences.

A cell-size study of our three male populations probably would be informative, except that we may not yet have achieved enough genetic difference or root size in our males to execute an effective study. The root yields of 17.6 and 15.7 kg/plot (Table 1) are barely different at $P = 0.05$. However, there probably is still sufficient genetic variance in our large- and small-root lines to make further progress toward isogenic lines differing only for root size. Isogenic may be a misnomer in this case, because if cell size is a factor in both root size and sucrose, true isogenic lines are impossible.

The other characters in the study were analyzed but do not contribute to conclusions about root size and combining ability. No differences were shown for juice purity, and the recoverable sucrose results were as expected, since recoverable sucrose primarily is a function of root yield and sucrose content. The nonsucrose juice components were interesting. Amino N declined with selection for large root, whereas small root selection had no effect. Potassium was affected the same way. Sodium was not significantly affected.

A breeding conclusion from this study is that, in the development of breeding lines for SCA, large root size should be avoided because large root size may reduce SCA effects. Further, if any SCA effects for sucrose content are present, they may be expressed only in small-root populations. If an analysis like this were made of similar female lines, it is logical to assume that they would perform like the males in this study.

It probably is necessary to point out that the differences and similarities that led to these conclusions are in some cases minimal, because we did not achieve a dramatic genetic change for root size, and we probably did not avoid making some genetic change for sucrose content in our small- and large-root populations. Further research may result in modifications of these conclusions.

RHIZOCTONIA ROOT ROT RESEARCH AND DEVELOPMENT OF GENETIC RESISTANCE IN SUGARBEET
(BSDF Project 202)

1989 Field Research on Rhizoctonia Root Rot of Sugarbeet.--R. J. Hecker and E. G. Ruppel.

The field research in this project was conducted on the Colorado State University South campus on a land area restricted to our rhizoctonia root rot research. Our ARS rhizoctonia research project involves cooperative inputs from both the

BSDF and Colorado State University. We are pleased to be able to lead this three-way cooperative research effort.

The 1989 field experiments were planted on an area that had been in barley for the previous 3 years. This was the site of our inoculated *Rhizoctonia* nursery in 1985. In 1989, no indigenous rhizoctonia root rot occurred before inoculation. Hence, the dense population of *Rhizoctonia* in the soil in 1985 essentially had been abated by the intervening 3 years of barley culture. All germplasm evaluation experiments were planted in one-row plots, 6.1 m (20 ft) or 4.3m (14 ft) long and 56 cm (22 in) apart. Experiments were planted May 18 and thinned June 19-23. Dry, ground, barley-grain inoculum of *Rhizoctonia solani* (R-9) was banded at 12 or 19 g/6.1 m (20 ft) over each row with a tractor-mounted four-row granule applicator. Experiment 4R, involving highly resistant germplasm, received the higher rate of inoculum, whereas all other experiments with more susceptible germplasms received the lower rate. Inoculation was done July 20, and our standard sprinkler irrigation regime was used to moisten and activate the inoculum.

Roots in all experiments were lifted September 18-21 and individually rated for rot. Disease index (DI) ratings were made on a scale of 0 to 7, with 0 = no evidence of infection and 7 = plant dead. The percentage of healthy roots were those with DIs of 0 and 1, those roots showing no active infection. The roots with DIs 0 through 3 also were analyzed as a class; these roots were sufficiently sound and large to be recovered in a commercial harvest. The epiphytotic of root rot in our 1989 rhizoctonia experiments was a little less severe than in 1988, but provided good evaluations of all germplasms tested.

Germplasm Development and Improvement for Rhizoctonia Root Rot Resistance.--
R. J. Hecker and E. G. Ruppel.

Sugarbeet losses due to rhizoctonia root rot continue to be a problem in most production areas, including the Red River Valley where it is increasing. The increased incidence of this disease in most beet-growing areas is due to several factors: (1) shortened crop rotations, (2) increased use of alternate host crops between beet crops, (3) cultivation practices that increase soil-crown contact, and (4) use of predominantly susceptible hybrid varieties. There are no labeled chemical controls for this disease. Hence, adequate rotation, good cultural practices, and tolerant hybrids are the only methods of control.

The objectives of this project are: (1) development of sugarbeets resistant to root-rotting strains of *Rhizoctonia solani* in genetic backgrounds that will facilitate incorporation of resistance into hybrid varieties; (2) development of new knowledge about the pathogen, host-pathogen interactions, and interactions of pathogen with cultural practices and other crops; and (3) biocontrol.

Our current emphasis is the improvement of resistance and introgression of resistance into breeding lines that are resistant to curly top or leaf spot and/or are CMS, monogerm, and O-type. Examples of these germplasms in various stages of development and our most resistant lines are shown in Table 1.

Most of the entries in Table 1 with high resistance to Rhizoctonia have been released and registered. FC709 remains our most resistant germplasm. Entry 615 is an unnumbered breeding line that has potential use as an O-type monogerm

pollinator in a CMS F_1 for production of 3-way hybrids. It is being improved for O-type and monogerm prior to its potential release. It is our experienced opinion that a commercial hybrid with resistance equivalent to FC709 or entry 615 would be sufficiently resistant to virtually eliminate field losses due to rhizoctonia root rot, especially when coupled with certain cultural practices known to suppress the disease. This level of resistance can be achieved only by having excellent resistance in all parents of a hybrid. Entry 615 has potential for improvement of resistance in CMS parents of hybrids.

Table 1. Means for rhizoctonia root rot assessment of germplasms in various stages of resistance development; 1989 inoculated field test.

Entry	Germplasm & description[2]	Disease[1] index	Healthy[1] roots (%)	Harvestable[1] roots (%)	Leaf spot rating (1989)	Curly top rating (1988)
616	FC709; MM	1.5	63	96		6.0
615	O-type, mm; release candidate	1.5	66	93		6.0
618	FC708; reindexed O-type, mm	1.6	56	95		
619	FC708CMS	1.9	40	93		
609	FC712; MM	1.8	55	92		5.9
595	FC703-5; MM	1.8	52	92		
579	O-type, mm, from FC702/LSR-CTR	2.0	43	85		5.2
614	FC702-7; MM	2.0	50	87	3.2	
589	FC707(4x); MM	2.1	41	91		
590	FC707-2; MM	2.1	46	88		
604	O-type, mm, from FC701/LSR-CTR	2.1	35	90	3.2	
575	Rh. sel. from FC703-5/Peramono	2.2	45	81		
578	Rh. sel. from high CA & suc. sources	2.6	33	66	3.5	
577	Rh. sel. from high CA sources	2.7	32	64	5.7	
576	Rh. sel. from FC703/high suc. sources	2.9	30	62		
580	Rh. sel. from C37/FC707-2; MM	3.0	29	61		4.7
569	Rh. sel. from FC712/diverse mm's	3.2	24	63		
570	Rh. sel. from diverse mm's/FC712	3.2	22	58		
571	Rh. sel. from high FC712/high CA LSR mono	3.3	17	56	3.0	
572	Rh. sel. from high CA mm/FC712	3.3	17	56		
580	Rh. sel. from C37/FC707-2; MM	3.0	29	61		4.7
600	Rh. sel. from Rhizoc resist/C718; mm, O-type	3.5	25	59		
601	Rh. sel. from C718CMS/Rhizoc. resist; mm	3.6	15	55		

Table 1. (continued)

Entry	Germplasm description[2]	Disease[1] index	Healthy[1] roots (%)	Harvest-able[1] roots (%)	Leaf spot rating (1989)	Curly top rating (1988)
564	Rhizoc. susc. check	5.3	7	24		
566	FC703; resist check	2.5	38	74		
565	FC705-1; high resist. check	1.9	49	87		
	Curly top check; US33					4.5
	Leafspot resist. check				3.2	
	LSD(.05)	0.7	NA	NA	0.9	NA

[1]Disease index = 0 (no disease) to 7 (all plants dead); healthy roots = no infection or small arrested lesions; harvestable roots = roots sufficiently large and sound to be included in a grower's harvest.

[2]MM = multigerm; mm = monogerm; LSR = leafspot resistant; CTR = curly top resistant.

FC708 has been reindexed for O-type and reselected for monogerm. This FC708, and FC708CMS, will be offered for distribution about November 1990. FC712 has been released; it is still one of our most resistant multigerm lines. FC703-5 is a candidate for release. It is a subline of FC 703 that has responded to additional selection pressure since the release of FC703.

Entries 578 through 601 are breeding lines in the process of development. They are efforts to introgress rhizoctonia resistance into germplasms that have high combining ability, high quality, leaf spot resistance, and/or curly top resistance. These lines have responded to selection pressure and currently are moderately rhizoctonia resistant.

A few of the entries also were tested for leaf spot and curly top (1988) resistance. Most of the few tested are leaf spot resistant but curly top susceptible.

Several more susceptible entries are shown in Table 2. Entry 290 is a line selected by Dr. Lewellen for rhizomania resistance from several of our rhizoctonia-resistant lines and obsolete Colorado cultivars.

Table 2. Rhizoctonia resistance assessment of new breeding lines and miscellaneous entries; 1989 inoculated field test.

Entry	Description	Disease index	Healthy roots (%)	Harvestable roots (%)
290	820; rhizomania resist	3.9	10	46
296	ACH 184	4.1	4	35
303	Sel. from C718/FC708,BC_1P_1	4.6	1	39
298	HM RH83	4.8	1	20
299	HH32	4.9	2	22

Table 2. (continued)

Entry	Description	Disease index	Healthy roots (%)	Harvestable roots (%)
300	AD-3; 4x Spanish pollinator	4.9	3	23
301	AD-1; " " "	4.9	4	21
293	Beta 4689	5.4	0	9
289	F1010; storage rot resist.	5.8	1	9
295	C309H3CMS/B883	6.1	0	13
288	F1009; storage rot resist.	6.4	0	8
294	B883; nematode resist	7.0	0	0
285	Rhizoc. susc. check	5.8	2	14
286	FC705-1; high resist. check	2.3	30	83
287	FC703; resist. check	3.8	8	50
	LSD (0.05)	0.7	NA	NA

[1]Disease index = 0 (no disease) to 7 (all plants dead); healthy roots = no infection or small arrested lesions; harvestable roots = roots sufficiently large and sound to be included in a grower's harvest.

[2]MM = multigerm; mm = monogerm; LSR = leafspot resistant; CTR = curly top resistant.

This project of breeding for resistance to root rotting strains of *Rhizoctonia* is producing germplasms increasingly useful to breeders of hybrid varieties. The germplasms described in this report have both current and future usefulness.

Rhizoctonia Root Rot Assessment of *Beta vulgaris* Germplasms--R. J. Hecker and E. G. Ruppel.

In our inoculated field tests, we assessed 34 exotic *B. vulgaris* germplasms for reaction to root-rotting *R. solani*. This research was in cooperation with the Crop Advisory Committee (Dr. Doney, Sugarbeet Chairman) and the ARS Plant Introduction Center, Ames, Iowa. The 34 entries were from Turkey, India, Iran, China, Manchuria, and the U.S.

All of the entries exhibited susceptible reactions to *R. solani*. This adds evidence to our previous observation that resistance to this fungus is exceedingly rare in indigenous *B. vulgaris* populations.

About half of the 34 entries bolted 50 to 100%, even though they were planted late, May 18. We consider the disease assessment of these annual types to be relatively accurate.

The data on disease reaction and several other characters have been transmitted to Dr. Doney for inclusion in the Germplasm Resources Information Network (GRIN).

Rhizoctonia Root Rot Effect on Yield of Varieties with Varying Amounts of Resistance--R. J. Hecker and E. G. Ruppel.

A concern among sugarbeet breeders, agronomists, and producers is the possibility of some loss of root and/or sucrose production in rhizoctonia tolerant hybrids even though obvious infection symptoms may be mild or absent.

To resolve this concern, we conducted an experiment in the field in 1989 at Ft. Collins, CO, in our *Rhizoctonia*-inoculated nursery. Five entries with different levels of rhizoctonia resistance were planted May 18 in 4-row, 20-ft plots. Inoculum was applied to half the plots (random) on July 20. Cultural practices were described in a previous section of this Project 202 report. On Sept. 21, the two center rows of each plot were lifted, rated for root rot, topped, washed, weighed, and analyzed for sucrose, and thin juice purity.

The disease index (DI) means of the five entries for the inoculated plots (Table 3) ranged from resistant (1.5) to susceptible (5.9).

HM 55 is a commercial hybrid that would have to be classed as susceptible under our test conditions; however, there are other commercial hybrids that are more susceptible. HM RH83 and ACH 184 are specialty hybrids marketed because they offer some resistance. The FC experimental hybrid is FC505CMS/FC708//FC712. Among the parents in this 3-way hybrid, FC505CMS is susceptible, and the two pollinators are resistant breeding lines. FC709 is the most resistant breeding line that we have among our developments.

Table 3. Disease index (DI), root yield, recoverable sucrose, sucrose, and purity of inoculated (I) and noninoculated (NI) entries having varied levels of rhizoctonia resistance.

Entry & description	DI		Root yield T/A		Recov. suc. T/A		Sucrose %		Purity %	
	I	NI	I	NI	I	NI	I	NI	I	NI
HM 55; sus. hyb.	5.9	1.6	14.0	19.6	1.20	2.52	11.2	15.0	84.7	93.1
HM RH83; med. resist. hyb.	4.9	0.5	9.7	18.5	0.69	2.45	10.1	15.2	78.9	93.8
ACH 184; med. resist. hyb.	4.6	0.5	11.9	22.0	0.85	2.89	9.6	15.6	82.9	92.8
FC resist. exp. hyb.	3.0	0.0	16.2	18.2	1.51	2.16	12.1	14.6	87.2	91.3
FC709; resist. breeding line	1.5	0.2	16.8	16.1	1.96	2.00	14.1	15.1	91.0	91.7
LSD (.05)	0.9		3.6		0.49		2.0		2.2	

The DIs for noninoculated plots indicate some modest infection of MH 55 (DI = 1.6), whereas the other DIs were not different than zero. This significant DI probably was due to inoculum imprecisely applied in a preceding plot.

The means in Table 1 indicate a direct relation of disease intensity with yield and quality. There was no reduction of root yield or recoverable sucrose in FC709 due to disease, and the 1% reduction of sucrose content was not significant. Hence, this experiment indicated that there was no hidden loss due

to *Rhizoctonia* as measured in our inoculated nursery. Rather, it appears that there may be a linear relationship between DI and the yield characters and that our resistant germplasm FC709 was unaffected by the pathogen.

Linear regression analyses within the inoculated plots of DI (X) vs. recoverable sucrose (Y_1), plot weight (Y_2), or % sucrose (Y_3) produced the following regression functions, respectively:

$Y_1 = -0.52X + 2.112$; (*P* of significance due to regression = 6.8%)
$Y_2 = -1.11X + 19.02$; (*P* of significance due to regression = 9.0%)
$Y_3 = -0.85X + 14.62$; (*P* of significance due to regression = 4.7%)

where compensations were made before analyses for effects due to entries. There were only 20 data points in the experiment, hence, the data were limited. However, the significance and near significance of the regression analyses indicated that predictive models might be developed from more extensive data.

Such equations could be used to estimate losses in fields that suffered various levels of *Rhizoctonia* infection. Experiments will be conducted in 1990 from which we will develop more precise loss prediction models.

Survival of *Rhizoctonia solani* in Fallow Field Soil, Trial 1.--E. G. Ruppel.

(Partial results of Trial 1 of this experiment were reported in *Sugarbeet Research, 1988 Report*.)

The experimental site, design, and methodology were described in last year's report. Herein are the results of Trial 1, which extended from June 1988 through June 1989. Trial 2 is in progress.

Root halves buried at 5 cm remained discernable for at least 6 months, although somewhat mummified by the 6th month (December 1988). After 2 months, root halves buried at 20 cm were completely broken down to organic residues; those buried at 10 cm were discernable at 4 but not at 6 months.

By 6 months, no *R. solani* was recovered from 5-cm root residue samples, and, by 8 months, the fungus could not be recovered from the 10- and 20-cm samples (Fig. 1A). Fig. 1B presents results of pathogen recovery from soil adjacent to the buried roots.

Generally, the percentage of samples yielding *R. solani* decreased steadily throughout the course of the experiment, but the fungus never completely disappeared. At the first sample date (August 1988), differences in recovery among soil depths were significant ($P = 0.05$), with the number of samples yielding the fungus being inversely proportional to the depth of soil. After the first 2 months, recovery was comparable at all depths. The higher densities of the fungus recovered from soil as compared with root residues most likely indicates that our assays recovered resident populations of this ubiquitous fungus as well as the sugarbeet isolate that may have grown from the root debris and colonized other organic residues in the soil. However, in pathogenicity tests with a 10% random sample of isolates of *R. solani* from the assays, all were able to induce root rot in sugarbeets in the greenhouse.

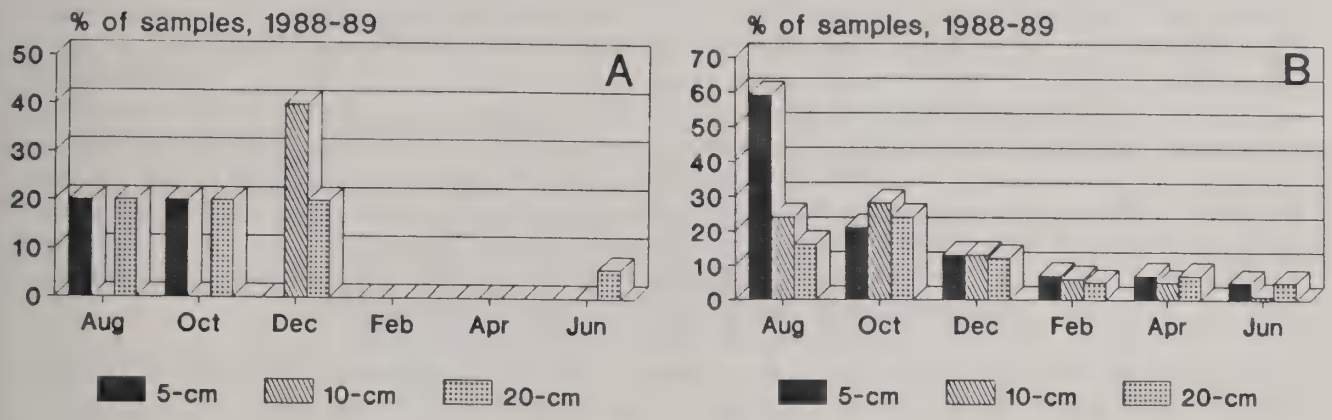

Fig. 1. Percent of samples yielding *Rhizoctonia solani* from infected sugarbeet roots buried at three depths (A) and from soil adjacent to the buried roots (B) as determined by assays on a *Rhizoctonia*-selective agar medium.

The rapid decline of the pathogen in root residues and adjacent soil in the upper soil profile undoubtedly is attributable to high soil temperatures (35-36 C) and relatively low soil moisture during summer. Pathogen decline was steady but somewhat slower in the lower soil profiles, which had cooler summer temperatures (16-26 C) and some, but not excessive, moisture.

Effect of Seed Priming on Sugarbeet Emergence, Seedling Survival, and Yield in the Presence of *Rhizoctonia solani* in the Greenhouse and Field.--E. G. Ruppel and R. J. Hecker.

Juvenile seedling tissue of sugarbeet and most plants is more susceptible to damping-off by various fungi. Means to increase emergence and maturation rate of seedlings may reduce stand losses caused by fungal pathogens. Moisture priming of sugarbeet seed has been shown to increase the rate of emergence of seedlings. Thus, primed seed was tested to determine its effect on diseases caused by *R. solani* in sugarbeet.

Greenhouse: A split-split-plot experiment arranged in a randomized complete block design with three blocks was conducted in the greenhouse to test the effect of priming on seedling emergence and survival over time. Three sugarbeet cultivars were included (main plots), soil was infested or noninfested with *R. solani* (root isolate R-9)(subplots), and seed treatments (sub-subplots) were compared. Dry, ground, barley-grain inoculum of *R. solani* was added to soil to give a population density of 0.2 fungus propagules per gram of soil; control soil received comparable amounts of autoclaved inoculum. Cultivars were Hilleshög MonoHy (HM) R2, HM1605, and HM1535. Seed treatments were as follows: primed plus fungicide, primed alone, a 24-hr water soak, and an untreated control. Solid-matrix priming of seeds was performed by Dr. Michael Boosalis (University of Nebraska, Lincoln) in cooperation with a commercial seed-treatment company. It consisted of moistening seeds and mixing with an organic carrier. The moisture content of the mixture was brought to a level just below that required for seed sprouting. Seeds were air-dried for 5 days after a 5-day priming

treatment, then planted in 10-cm-diameter clay pots (10 per pot). Fungicide seed treatment consisted of metalaxyl plus thiram applied as a slurry at recommended label rates during priming. The soil was irrigated immediately and, thereafter, as needed. Daily counts of seedling survival were made beginning 3 days after planting through 21 days. At 21 days postplanting, surviving seedlings were harvested, tops and roots were separated and oven-dried for 24 hr, and the dry weight of tops and roots per plant were calculated. An analysis of variance (AOV) was performed on seedling emergence or survival data for each day's counts as a percent of the noninfested control and on percent of possible stand survival. Because count data followed a Poisson distribution and variances were proportional to the means, count data were transformed to log (x + 1) for statistical analyses. The arcsine-square root transformation was applied to percent data for analyses, but actual percentages are presented.

There were no significant differences among the three sugarbeet cultivars in any AOV. Likewise, there generally were no significant treatment X cultivar interactions. Thus, data are presented across cultivars. Although data were collected daily, only results from alternate days are presented, beginning with day 4. Because there were no significant treatment differences after day 8, data are presented only through day 14.

Seedling emergence (4 days) and survival (6-14 days) are shown in Fig. 1. At 4 days, the water-soak treatment was significantly ($P = 0.05$) better than either primed treatment, and the primed treatments were not significantly better

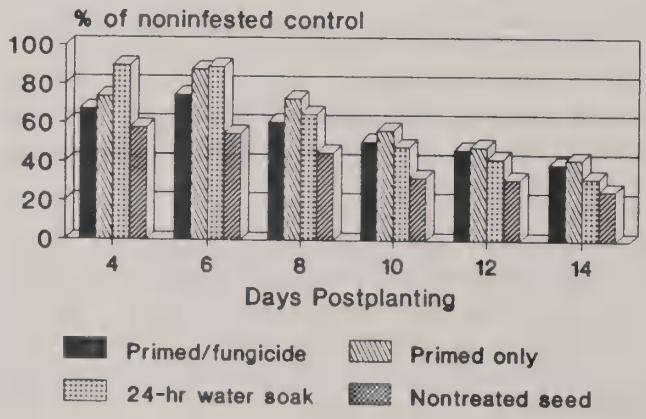

Fig. 1. Effect of solid-matrix seed priming with and without metalaxyl + thiram fungicide or a 24-hr water soak on sugarbeet seedling emergence (4 days) and survival (6-14 days) in soil infested with *Rhizoctonia solani*; means of three replicates presented as % of the noninfested control; data across three cultivars.

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than the untreated control. The primed-only treatment reached the level of the water-soak treatment by 6 days, then was slightly, but not significantly, better than all treatments for the duration of the test. At days 6 and 8, differences among the three priming treatments were not significant, but all were significantly better than the control; thereafter, no treatment differences were significant. The trend for slight, but nonsignificant, lower survival in the primed plus fungicide treatment indicates some deleterious effect of the fungicide on seedling emergence and survival.

When data are presented as percentage of possible stand (Fig. 2), seedlings from seed treated by the solid-matrix method (with or without fungicide) emerged significantly ($P = 0.05$) faster than seedlings from untreated seed or seed given a 24-hr water soak. After day 4, however, there were no significant treatment differences.

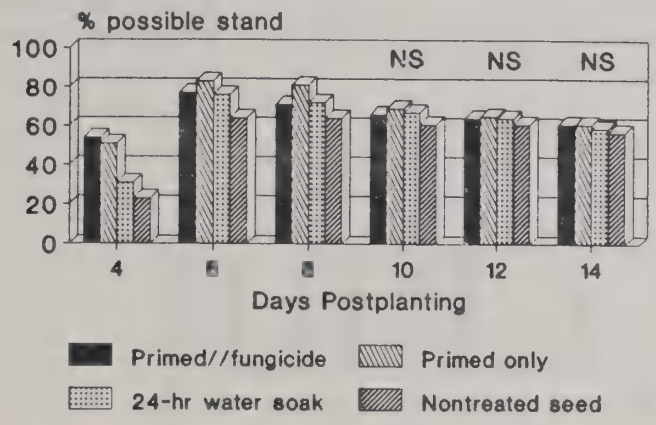

Fig. 2. Emergence (4 days) and survival (6-14 days) of sugarbeet seedlings from primed seed as a percentage of possible stand; means of three replicates across three cultivars and soil infestation treatments.

There were no significant differences among treatments in top dry weight per seedling at 21 days postplanting (data not shown). Dry weight of roots per seedling differed significantly; however, there was a cultivar X treatment interaction. The trend was for heavier root biomass in seedlings given the primed plus fungicide treatment (data not shown).

Field: A randomized complete block design with four replicates was used to test the effect of priming on seedling emergence, seasonal plant stands, and yield of sugarbeet in the field in 1989. Two-row plots were 4.3 m long, with 56 cm between rows and a within-row plant spacing of 20-25 cm. Two sugarbeet cultivars were planted on May 19 in a field site known to be infested with *Rhizoctonia solani* (site of 1988 Rhizoctonia breeding nursery). Cultivars were Hilleshög MonoHy (HM) D2 (susceptible to *R. solani*) and ACH184 (moderately tolerant to *R. solani*). Seed treatments were as follows: primed plus fungicide (metalaxyl + thiram), primed alone, fungicide alone, and an untreated control. Solid-matrix priming and fungicide treatment were performed by Dr. M. Boosalis as described for the greenhouse test. Counts of plant stands were made at 8, 12, 25 (just before thinning), 69 (6 wk postplanting), and 136 days postplanting (harvest). The first three counts were made on one row of each plot, whereas both rows were counted at 69 and 136 days. At harvest (October 2), all roots were dug and rated for rot on a scale of 0-7, with 0 = no rot and 7 = completely rotted, plant dead. A disease index (weighted average based on the number of plants in each disease class) was calculated for each plot. Plants in classes 0 and 1 were considered healthy and were used to calculate the percentage of healthy plants. Roots 5 cm or more in diameter were topped, washed, and weighed for root yield. Standard procedures were used to calculate percent sucrose and purity of brei. The same transformations of data were used for statistical analyses as described for the greenhouse study.

There were no significant differences between cultivars, and there were no significant cultivar X treatment interactions at any counting date. Therefore, only treatment data are presented.

At 8 days postplanting, emergence from the primed-only treated seed was significantly greater than the unprimed treatments, but not significantly different than the primed/fungicide treatment; the latter was not significantly different from the unprimed treatments (Fig. 3). There were no significant differences among treatments after day 8.

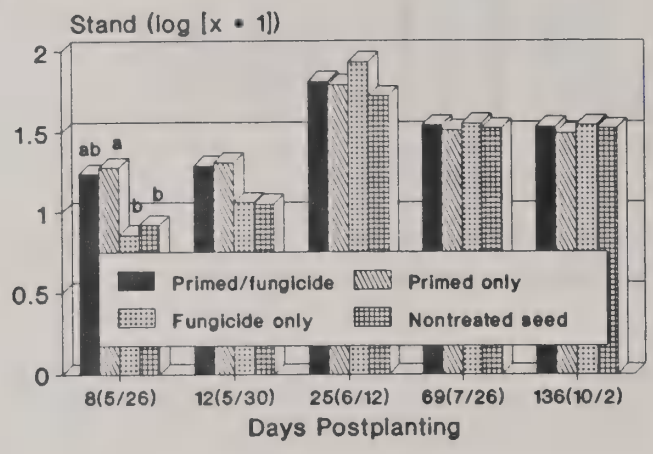

Fig. 3. Stand counts (log [x + 1]) at various days postplanting from seed given priming and fungicide treatments and planted in a field site infested with *Rhizoctonia solani*; means of four replicates across two cultivars; bars with the same lowercase letters are not significantly different at $P = 0.05$ according to Duncan's multiple range test. After 8 days, there were no significant treatment differences.

At harvest, there were no significant differences between cultivars or among treatments in final plant stand, disease index, percent healthy roots, root yield, percent sucrose, or purity. Because no trends were evident, no data are presented for these parameters.

Solid-matrix priming of sugarbeet seed did speed up the rate of seedling emergence in both the greenhouse and field, but the positive effect lasted for only a short duration. Ultimately, as shown by the field study, there was no beneficial (or deleterious) effect on important yield parameters.

The data in Figs. 1 and 2 seem to indicate that priming reduced seedling loss due to the fungus. However, differences in survival were not significant after 8 days postplanting. Ultimately, about 40% of the seedlings were lost due to damping-off regardless of seed treatment.

In the field test, little can be concluded about the effects of priming on stand loss or rot of mature beets. Very few seedlings damped off and very few roots showed rot symptoms at harvest, although climatic conditions and the soil population density of *R. solani* were conducive to the development of disease. The reason for the low incidence of disease in this field test is unclear, especially since Rhizoctonia root rot was severe in our adjacent inoculated breeding nursery.

EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO RHIZOCTONIA ROOT ROT (BSDF Project 203)

E. G. Ruppel and R. J. Hecker.

Randomized complete block designs with five replicates were used to evaluate 156 contributed lines from seven BSDF-member companies. Internal controls included highly resistant FC 705/1, resistant FC 703, and highly susceptible FC 901. The experimental design, methods, results, and statistical analyses were sent to the appropriate company breeders. The mean disease indexes (DIs) for FC 705/1, FC 703, and FC 901 across all contributor tests were 1.7, 2.9, and 5.7, respectively (increasing disease on a scale of 0 to 7, with 7 = dead). Percent healthy means were 59, 31, and 3, whereas percent roots in classes 0 through 3 were 86, 56, and 10, respectively. DIs of contributor lines ranged from 1.7 to 6.8, and from 0 to 62% healthy roots.

LEAF SPOT EVALUATIONS OF SUGARBEET LINES SUBMITTED BY BSDF-MEMBER COMPANIES (BSDF Project 255)

E. G. Ruppel and G. A. Smith

Separate randomized complete block designs with two replicates were used to evaluate 127 lines submitted by five BSDF-member companies for resistance to *Cercospora beticola*. Internal controls were a highly susceptible synthetic and a resistant check, FC(504 X 502/2) X SP6322-0. Two-row plots were 4 m long with 56 cm between rows and a 20- to 25-cm within-row plant spacing. We inoculated twice (June 27 and July 3), and evaluations were made on August 15, 31, and September 5.

Our epidemic was not as severe as in 1988. On our disease scale of 0-10, the resistant and susceptible checks had mean disease indexes of 2.8 and 5.9, respectively, across all contributor tests on September 5. Means of contributor lines on this date ranged from 2.0 to 7.5. Means of the individual tests were tablulated, statistically analyzed, and sent to the appropriate contributor.

IN VITRO POLLEN TECHNOLOGY TO ASSAY AND SELECT FOR ECONOMIC CHARACTERS IN SUGARBEET (BSDF Project 760)

R. J. Hecker

The objective of this project is development of in vitro techniques with pollen or other tissue to assay plants or populations for genotype or genetic worth, and to make genetic selection. Our experiments in the project are primarily tests of the hypothesis that genetic characteristics of the sporophyte can be identified and/or selected in the gametophyte (pollen). Because pollen is haploid and millions of different genotypes can be contained in a few petri dishes, this tissue has potential to be manipulated like microorganisms. Also, pollen has many advantages over callus or suspension culture because the pollen genotype cannot be hidden by dominance or epistasis, as it usually is in all types of sporophytic tissue. However, pollen is not regenerable and can only be used to fertilize ovules that have not been subjected to the same challenge or selection as the pollen. This is not a serious problem because, after the one rare genotype has survived some challenge and has fertilized an ovule and all other pollen has been killed, the resultant plant will have a relatively simple segregation and conventional plant selection and breeding can be applied thereafter.

Subsequent sections within this project report results for pollen challenge experiments and other experiments related to use of pollen as a tissue for sugarbeet breeding.

In Vitro Assay for Resistance of Sugarbeet to *Rhizoctonia solani*.

Our development of rhizoctonia root rot resistant germplasm has been accomplished by phenotypic selection in September of field grown plants that had been inoculated in mid-July. The technique has been successful, as a part of cyclic mass selection, in accumulating quantitative genes for resistance. The next step in breeding is the introgression of the genes for resistance into the parents used in the best commercial hybrids. This is the job of sugarbeet breeders and requires hybridizations, then selection and reselection in segregating generations. This is where a more rapid and precise assay for resistance is needed in order to make this breeding phase progress rapidly.

We reported last year that two commercially produced pectolylic enzymes had differential effects, although not consistent, on pollen from susceptible and resistant sugarbeets. Pectinase and pectolyase usually enhanced in vitro pollen germination of susceptible sources but did not affect pollen from resistant sources. These same enzymes usually induced more K^+ leakage from pollen of resistant sources than from susceptible sources. Cellulase enhanced germination of susceptible sources and had no effect on resistant sources. Cellulase induced the same amount of K^+ leakage in both pollen sources. In general, our results were sufficiently consistent for germination or K^+ leakage to be used as an identifier of resistant and susceptible genotypes.

This year we have found that K^+ leakage from pectinase-incubated root-tissue disks of resistant and susceptible plants was somewhat greater than from disks of resistant sources, but root-to-root variability was larger than differences between sources. Hence, identification of resistant individuals was not possible.

In cooperation with Dr. Bugbee (ARS, Fargo), we tested for differential effect of pectin lyase on pollen and tissue of resistant and susceptible beets. He had purified the enzyme from cultures of a root-rotting *R. solani* strain in a medium amended with sugarbeet cell walls.

The pectin lyase from Dr. Bugbee had a potent effect on pollen germination. In vitro germination was essentially inhibited at 0.03 relative viscosity units (RVU) per ml of medium. At all lower concentrations tested, we found no consistent differential germination inhibition of pollen from resistant and susceptible sources. Similar comparisons showed a tendency toward higher K^+ leakage of pollen from resistant plants, but the effect was not large or consistent. Disks of leaf and root tissue, from resistant and susceptible plants, incubated in pectin lyase did not leak K^+ differentially.

In our numerous experiments, we have not discovered an in vitro technique that precisely identifies rhizoctonia-resistant plants. The next phase of this cooperative research will examine in vitro interactions of rhizoctonia enzymes with resistant and susceptible genotypes.

Challenge and Selection of Pollen for Cool Temperature Tolerance.

This portion of the project is designed to test the hypothesis that pollen that is able to survive and function at low temperature will produce progeny that germinate, emerge, and develop more rapidly in cold soil.

We challenged pollen two ways. The first method was a challenge of pollen by low temperature during fertilization. Four cycles have been completed, and most test data was reported last year. One year of additional field testing is being reported this year. The second method was chilling injury of pollen during humidification, which has been done for three cycles. The data are included in this report.

The first challenge method was described in our 1988 report. Briefly, in a heterogeneous population assumed to contain genetic variability for cold tolerance because of its parentage, male sterile segregants were pollinated several times with sib pollen at 8C. Resultant progeny were used for the next cycle. Remnant seed was used to test root elongation rate of 12 and 24C. Pollen of the progeny used for the next cycle was tested for in vitro germination and tube length at low temperature. Remnant seed also was tested for growth to the 6-leaf stage at 15/10 and 24/19-C days. Increases from remnant seed were used for growth chamber emergence tests and for field emergence and yield tests. Four cycles of challenged fertilization were completed. Among our several comparisons of source population with 4th-cycle challenged population, only pollen tube length after 6 and 24 hours at 8 and 12C, and seedling emergence in 10C soil showed an advantage for the 4th cycle population at low temperature. In all other tests the population that resulted from four cycles of challenge was not different than the source population. The conclusion is that our method did not

effect much, if any, genetic gain for ability to function more efficiently at low temperature, or there may have been insufficient genetic variability in the source population.

Our second challenging method was done on pollen from two separate populations segregating for male sterility (MS), both of which are assumed to contain genetic variance for cold tolerance due to their parentage. This method consisted of pollen desiccation followed by 24 hours of humidification at 2C. It is this combination that is stressful to pollen (Hoekstra, F.A. Pl. Physiol. 74:815-821). The challenged pollen was blown onto MS sib plants in greenhouse isolators. Several pollinations were made within each population. The method resulted in average pollen survival of 21 to 58% for the six times used (3 cycles X 2 populations). Another technique of submersion of desiccated pollen into 2C water for 5 min caused 18 to 39% pollen survival, but the pollen was in a slurry and had to be hand applied to individual MS flowers, which limited the amount of seed that could be produced. The former method of challenge was used for three cycles. The tests for genetic gain have been pollen germination and tube length at 12 and 24C, as well as root elongation rate at 12 and 24C. These data are in Table 1. The easiest data to interpret are the ratios of 12 to 24C performance, expressed as %. These six pairs of ratios do not consistently indicate that the two 3rd-cycle challenged populations performed in a more cold tolerant manner than their two original populations. The 3rd cycle, 891053, may show more progress than the other challenged line; e.g., germination the 12/24C performance ratio was 42% compared with 29% for its original source, and seedling root elongation was 79% compared with 60%, respectively. We have not had sufficient seed for soil emergence comparisons in the field or growth chamber. Hence, results are not definitive, so a 4th cycle of pollen challenge is in progress.

Our mixed and inconsistent results could indicate (1) that gametophytic cold tolerance is not universally expressed in the sporophyte, (2) that the low temperature challenge was not sufficiently lethal to the pollen so that only the most cold tolerant genotypes survived, (3) that there was insufficient genetic variability in the source populations, (4) that many genes condition the character, (5) that sampling and environmental variability were too large relative to the treatment effect. One more cycle is planned; however, the challenge method will be modified to effect greater lethality.

Table 1. Root elongation, pollen germination in vitro, and tube length of the 3rd cycle of pollen challenge by low temperature in two sources and their original unchallenged populations.

Temp, and Character	891052 3d cy.	$\frac{12^{o}}{24^{o}}$(100)	Source of 891052	$\frac{12^{o}}{24^{o}}$(100)	891053 3d cy.	$\frac{12^{o}}{24^{o}}$(100)	Source 891053	$\frac{12^{o}}{24^{o}}$(100)
Germination (%)								
12C	2.2		4.0		5.9		2.8	
24C	10.6	22%	12.5	32%	14.1	42%	9.8	29%
Tube length (μM)								
12C	218		178		88		125	
24C	328	66%	245	73%	738	12%	568	22%
Root elongation (MM)								
12C	12.3		11.5		10.6		9.4	
24C	13.2	93%	13.3	86%	13.7	77%	15.8	59%

Salinity Challenge of Pollen.

We now have completed three cycles of pollen challenge by salinity and have started the fourth cycle. I will describe techniques and results.

We commenced with a heterogeneous S-cytoplasm population that was segregating for O-type, which resulted in about 60% CMS plants and 40% pollen fertile (PF) sibs. After testing for appropriate salt (NaCl) concentration, 100 mg of pollen from PF plants was put into 3 ml of a 4.5 M NaCl solution for 1 hour at 23C and stirred frequently. Two methods of handling were (1) direct, where the saline solution with pollen was applied one drop per stigma on CMS sibs of the PF plants; and (2) washed, where the saline-pollen solution was centrifuged 5 minutes at 5000 rpm to separate the pollen, then the saline liquid was removed, pollen was resuspended in our standard 32% sucrose-boron-calcium germination medium, it was recentrifuged, and the pollen slurry was applied in droplet quantities to CMS flowers. This second method resulted in more and better quality seed, and was used for succeeding cycles of salinity challenge. We attempted to pollinate at least 100 receptive stigmas per plant, but frequently did as few as 40 because of limited pollen. The average seed production per plant was 1.3, 0.6, and 0.1 g in the first, second, and third challenge cycles, respectively, producing about 60% viable seed. The average pollen lethality due to salinity challenge was 96.6 and 93.4% in the first and third cycles, respectively. The second cycle pollen was not tested, because pollen quantity was limited and it was all needed for pollinations. To assess for salinity tolerance in the generations following each challenge cycle, we measured in vitro pollen germination and tube length after 24 hours at 23C in media of electrical conductivity (EC) 0 and EC 8 (0.77 M NaCl). We also measured seed germination and root elongation at EC 0 and 8 after 4 days at 24C, provided we had sufficient remnant seed after starting plants for the next cycle.

Figure 1 shows germination and germ tube length of pollen from plants that were the product of three cycles of pollen challenge. The only evidence of change in salinity tolerance is the stability of the third cycle population between EC

2 and 4. Both germination and tube length of the control (source) population were affected significantly by the increased salinity (EC 2 to EC 4), whereas the third cycle population was unaffected in this sector of the EC range.

Our salinity tolerance tests of seed (sporophyte) showed no effect of EC 8 on seed germination in the second cycle or control populations. Radical length was significantly reduced in the EC 8 environment, but the reduction was the same in both populations.

Evidence of change in salinity tolerance after saline challenge of pollen was demonstrated only in the gametophyte (pollen), not in the sporophyte (seed). The fourth cycle of challenge (in progress) will be completed, then assessed for effect. A decision then will be made about the need to test the sporophyte in soil.

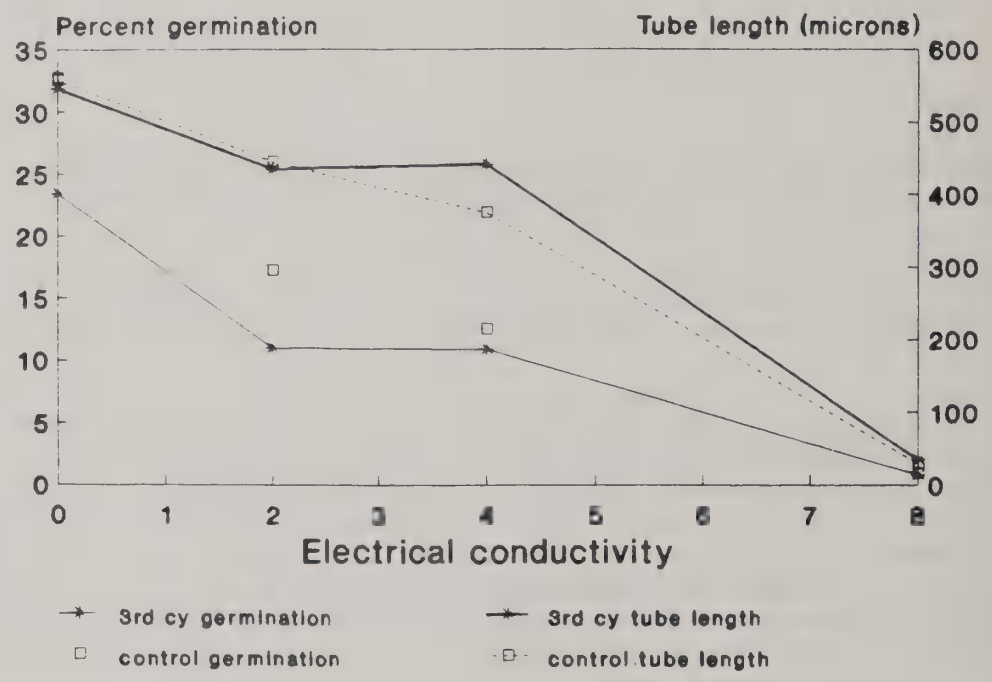

Fig. 1. Pollen germination and tube length in media with different electrical conductivities; pollen from third cycle of salinity challenge and from original source plants (unchallenged).

Gametophyte-Sporophyte Complementation in Relation to Hybrid Vigor.

This report is the conclusion of experiments to test for a relationship between hybrid vigor or root yield and specific pollen-stigma interaction. The hypothesis in these experiments is that combining ability for root yield can be predicted from complementation of pollen tube and stigma when two sources of pollen compete during fertilization.

To test the hypothesis, I used 20 pairs of half-sib hybrids that in preliminary field tests appeared to be different for root yield. Controlled greenhouse pollinations were made of the two pollinators onto a CMS, which constituted one pair of half-sib hybrids. Twenty such mixed pollinations were made. For each hybrid pair, the CMS parent (green hypocotyl) was pollinated with pollen collected from the two males (one green, rr, and one pink hypocotyl, R_); the pollen was mixed in proportion to its viability as determined by a fluorescein diasetate (FDA) viability test. This mixed pollen was blown onto the open CMS flowers of isolated plants. Several such pollinations were made to insure adequate seed production. Each pollen collection was tested for viability.

It was assumed that the two sources of pollen had equal potential to fertilize the CMS flowers. Further, it was assumed that the first pollen to germinate and/or the fastest growing pollen tubes effected fertilization. Hence, I compared the frequency of successful fertilization by the two different pollens, and compared this fertilization frequency with the expected frequency based on equal probability of fertilization. The deviation of obtained frequency from expected was called the complementation index (CI). The sign of the CI was determined by whether or not the frequency deviation was in the same direction as the heterosis of the two half-sib hybrids.

In Table 2, 20 pairs of half-sib hybrids are listed. After 2 or 3 years of field testing at Fort Collins, 13 of the 20 pairs of half-sib hybrids were significantly different for root yield. Among these 13, six had frequency deviations of hypocotyl colors in progeny from controlled pollinations in the direction of the male that produced the high-yield hybrid, i.e., had significant positive complementation indexes. One deviated in the opposite direction and had a significant negative CI. Six of the 13 hybrid pairs had significantly different root yields but nonsignificant CIs. Among the seven hybrid pairs with similar root yields, two had significant positive CIs, three had significant negative CIs, and two had CIs not different than zero. The correlation of CI with heterosis percentage was not significant ($r = 0.11$) among the 13 hybrid pairs differing for root yield, nor among all 20 hybrid pairs ($r = 0.10$).

If this complementation indexing method had been used as a method of screening for combining ability among these 20 pairs of hybrids, eight positive CIs would have been detected. Then, had seed of the hybrids been generated and field tested, six (hybrid pairs 1, 2, 4, 13, 7, and 3) of the eight would have shown combining ability differences. Thus, six true positives and two false positives (hybrid pairs 10 and 15) were generated by the CIs. Conversely, among the 12 with negative or nonsignificant CIs, seven would have shown significant combining ability differences (hybrid pairs 22, 20, 16, 5, 17, 6, and 11). The risk of lost effort due to two false positives out of eight is acceptable in most plant breeding programs. A greater potential loss might occur due to the discard of seven out of thirteen potentially good hybrids because of nonsignificant or negative CIs.

Although pollen-stigma complementation was only partly successful in detecting heterosis for root yield, part of the problem may have been due to inadequate assessment of pollen viability at the time the two male pollens were mixed and applied to the CMS. The FDA test for pollen viability has since been improved (J. Sugar Beet Res. 26:40-48. 1989). Obviously, there also was a problem with the mixed pollination of hybrid pair 6, where 94% of the seed resulted from pollination by the low-combining pollinator.

In practice, a complementation test probably could be used for preliminary screening for specific or general combining ability (SCA or GCA). In the first case, a number of new pollinators could be screened for SCA on a proven CMS by mixing the pollen of each pollinator with pollen of the red beet top-cross tester, or with pollen from a tester having another homozygous dominant character. The relative frequency of seed produced by each pollinator might serve as a SCA ranking. Mixed pollinations in all possible pairs of pollinators (provided hypocolyl color or other appropriate marker genes were present) could be made on a proven CMS. However, 10 pollinators would require 45 mixed pollinations, 100 pollinators would require 4950 mixed pollinations, etc., clearly an impossible task for most breeding stations. GCA assessment could be accomplished similarly by the use of a GCA tester CMS, or by comparing groups of pollinators for their relative abilities to compete with the red beet tester for fertilization.

In an attempt to find a pollinator superior to an existing pollinator when crossed with a proven CMS, mixed pollinations of the proven pollinator with each of a number of new pollinators could be done to detect CIs favoring new pollinators.

Concerned that incompatibility might interfere with complementation, some experiments were conducted wherein pollen germination media were augmented with stigmas and stigmatic extracts of various self-compatible and incompatible combinations. With this technique, we detected no apparent effect on pollen germination due to incompatibility. The type of comparisons made in these experiments have been concluded. However, other in vitro methods are being tested to detect gametophyte-sporophyte complementation.

Table 2. Heterosis % between half-sib hybrid pairs, expected and obtained frequencies of pink hypocotyl progenies from controlled pollinations of hybrid pairs, and gametophyte-sporophyte complementation indexes.

Hybrid pair	Years of field yield tests	Heterosis %	Pink Hypocotyl frequency		Complement. index
			Expected	Obtained	
1	2	42*	.42	.47	+.05*
22	3	31*	.46	.45	+.01NS
2	3	26*	.31	.37	+.06*
4	3	25*	.50	.43	+.07*
20	3	21*	.46	.45	+.01NS
13	3	20*	.37	.53	+.16*
7	3	18*	.50	.72	+.22*
16	3	18*	.31	.32	+.01NS
3	3	17*	.50	.37	+.13*
5	3	17*	.36	.38	+.02NS
17	3	16*	.39	.35	+.04NS
6	2	15*	.50	.94	-.44*
11	2	14*	.50	.47	-.03NS

Table 2. (continued)

Hybrid pair	Years of field yield tests	Heterosis %	Pink Hypocotyl frequency Expected	Pink Hypocotyl frequency Obtained	Complement. index
12	2	7NS	.34	.45	-.11*
19	3	7NS	.43	.44	-.01NS
10	3	6NS	.50	.62	+.12*
14	3	6NS	.39	.24	-.15*
8	2	3NS	.50	.62	-.12*
9	2	2NS	.50	.53	-.03NS
15	2	2NS	.39	.46	+.07*

Pollen Size and Variance in Relation to Sporophytic Heterozygosity.

Hybrid vigor of sugarbeet is necessary to maximize sucrose production. Genetic heterozygosity is necessary to produce hybrid vigor. Because pollen may have potential as a tissue for research and breeding in sugarbeet, this study was designed to examine the relation of pollen size and variance with heterozygosity.

Three inbreds and four heterozygous varieties or hybrids, all diploid, were induced to flower in the greenhouse about 6 months postplanting. Pollen was collected from five plants per entry in two samplings at early and late flowering stages. About 50 pollen grains per sample were measured for a total of about 1000 per entry.

The means and variances are given in Table 3. Genotype appeared to be the main determinant of pollen size. All three inbreds had different size pollen, whereas pollen of heterozygous entries were the same size. Inbreds as a group had larger pollen and higher variances than the heterozygotes. The variances of individual entries were not related to genetic heterozygosity. Pollen from plants in the early stage of flowering (1 week after first flowers) was larger and less variable than from plants sampled 5 weeks after first flowering.

Table 3. Means and variances of pollen diameter from homozygous and heterozygous sugarbeets.

Entry Class	Diameter μM	Variance
Homozygous		
SLC03	21.51b*	1.206d*
52-497	22.04a	3.789a
52-305	19.61d	2.058c
Heterozygous		
54-411/Red TC tester	20.58c	2.099bc
Red TC tester	20.52c	2.390b
52-305/GW359	20.34c	1.245d
GW359	20.32c	2.333bc

Table 3. (continued)

Entry Class	Diameter μM	Variance
Homozygous	20.98A*	3.329A*
Heterozygous	20.43B	2.833B
Early flowering stage	20.84AA*	2.775BB*
Late flowering stage	20.53BB	3.446AA

* Means or variances not followed by the same lower case letter are significantly different ($P = 0.05$); likwise for upper case letters.

From this experiment, it appears that there is no relation between genetic heterozygosity and variance of pollen size. Variability of pollen size or pollen size per se appear to have no potential for screening for genetic heterozygosity, hybrid vigor, or combining ability.

Long Term Pollen Storage:

In July 1985, sugarbeet pollen was collected, desiccated to 9.3% moisture, divided into 10 12-mg samples, and cryopreserved in liquid nitrogen. When samples have been removed, they were warmed at 24C for 30 minutes, then humidified for 30 minutes. In vitro pollen germination in liquid medium at collection, 6 months, 1, 2, 3, and 4 years was measured, along with pollen tube length, viability stain reaction, seed set after pollination, and viability of seed (Table 4). After pollen germination and viability tests, remnant pollen was blown onto flowering male-sterile plants. Seed set was the percentage of open flowers at pollination that produced an apparent seed. Viable seed was the percent of those seed that germinated.

Table 4. Tests of cryopreserved sugarbeet pollen.

Time in liquid N	In vitro germ. (%)	Tube length (μm)	FDA stained (%)	Seed set (%)	Viable seed (%)
Control (24 hrs)	32	-	-	-	-
0.5 yr	29	361	-	33	21
1 yr	34	275	-	-	9
2 yr	38	547	88	3	83
3 yr	22	491	77	12	92
4 yr	23	462	90	4	36

Pollen viability, as measured by in vitro germination afer 3 and 4 years of storage, was 22 and 23%, respectively. The test that will be done in 1990 (year 5) may confirm that there has been a viability decline from the original control

test (32%), which had been in liquid N for 24 hours. The apparent decline of seed set and seed quality in year 4 should be viewed with caution. The quantity and quality of seed could be heavily influenced by the condition of the female flowers, environment at the time of fertilization, etc., and may not be due to reduced pollen quality. Pollen samples that remain in liquid N for testing after year 5, 10, 15, and 20 will allow assessment of liquid N storage as a technique for germplasm preservation. It is apparent after year 4 tests that the technique should be useful for breeders to preserve pollen for later use in a breeding program after progeny tests or other breeding assessments have been completed.

SUGARBEET RESEARCH

1989 Report

SECTION D

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Colorado State University Experiment Station
Minn-Dak Sugar Cooperative
Minnesota Agricultural Experiment Station
North Dakota Agricultural Experiment Station
Sugarbeet Research and Education Board of
Minnesota and North Dakota

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CONTENTS

Bugbee, W. M. and L. G. Campbell. 1990. Combined resistance in sugar beet to *Rhizoctonia solani*, *Phoma betae*, and *Botrytis cincerea*. *Plant Disease* 73: (in press).

Germplasms FC 701/4 and FC 712 with resistance to crown and root rot caused by *Rhizoctonia solani* originally were developed at Ft. Collins., Colorado, and germplasms with resistance to storage rot caused by *Phoma betae* and *Botrytis cinerea* originally were developed at Fargo, North Dakota. The results of three greenhouse experiments and a field test showed that germplasms F1002 and F1004 selected for resistance to *P. betae* and *B. cinerea* also possessed a moderate level of resistance to *Rhizoctonia solani*. F1002 originally was selected from FC 701/4. F1004 originally was selected from a USSR germplasm that had been developed for resistance to storage rot caused by *B. cinerea*. A storage rot evaluation experiment showed that the *R. solani*-resistant germplasm FC 712 was as resistant to *P. betae* and *B. cinerea* as were germplasms developed specifically for storage rot resistance. The hybrid cultivars ACH 139, with resistance to *R. solani*, and ACH 146, with resistance to *Aphanomyces cochlioides*, were moderately resistant to *P. betae* and *B. cinerea*. These results place added value on those germplasms with combined root and storage rot resistance and suggests that *R. solani*-resistant cultivars will store better than *R. solani*-susceptible cultivars.

Bugbee, W. M., L. G. Campbell, and M. El-Kholi. 1989. Seedling response of storage-rot-resistant sugar beets to *Phoma betae* and *Rhizoctonia solani*. *J. Sugar Beet Res.* 26(3-4):33-39.

Five sugar beet germplasms resistant to storage rot caused by *Phoma betae* also were found to be resistant in the seedling stage. Temperatures of 15 or 25 C did not significantly affect the resistant response of seedlings in relation to controls. Seedlings resistant to *P. betae* were not resistant to *Rhizoctonia solani* anastomosis groups 2-2 and 4. The results demonstrated the existence of genetic resistance to Phoma seedling disease and that the resistance can be selected in mature harvested roots.

Campbell, L. G. 1990. Sugarbeet germplasm selected from the USDA collection. *North Dakota Farm Research* 47: (in press).

Five sugarbeet germplasms, F1010 - F1014, were developed by the USDA-ARS and the North Dakota Agricultural Experiment Station. All five have relatively high sucrose concentration and all were selected from the USDA-ARS *Beta* germplasm collection (NC-7) maintained at Ames, Iowa. F1010 resulted from five cycles of selection based upon both family and individual root sucrose concentration. The average weight of selected beets was approximately equal to the weight of the hybrid checks, thus preventing the drastic yield decline often associated with selecting solely for sucrose concentration. F1011 - F1014 resulted from selecting within accessions with relatively high sucrose concentration.

These germplasms make readily available a portion of the genetic diversity within the USDA NC-7 collection. They are intended to provide unique genetic sources for the development of populations and parental lines with improved agronomic performance.

Doney, D. L. 1989. Population dynamics of *Beta vulgaris* ssp. *maritima* (sea beet) in the British Isles. Report of International *Beta* Genetic Resources Workshop, Wageningen, The Netherlands, February 7-10, 1989. IBPGR, Rome, Italy.

Native populations of wild exotic plant germplasm may shift in location and genetic makeup due to natural and man-imposed environmental changes. Recent discoveries of pest resistant germplasm in *Beta vulgaris* ssp. *maritima* has focused interest on the status of native populations and the need to collect and preserve this subspecies. The British Isles collection (from the 1987 expedition) of ssp. *maritima* was evaluated in field trials for leaf thickness, length, and width, petiole length and width, and leaf dry weight and dry matter percentages. More detailed greenhouse studies were conducted for the same characters in seven different populations. Compared to sugarbeet, the British Isles sea beet generally has smaller (length and width) and thicker leaves with lower percent dry matter. The petioles are also smaller (length and width) than sugarbeet. Significant variation in leaf characteristics exists among sites (locations) and among plants within sites. Older populations are dynamic, i.e. crossing among plants and segregation within plants. A distance of 25 to 50 km provides sufficient isolation to induce a shift in gene frequencies and enhance the formation of distinct ecotypes.

Doney, D. L., E. D. Whitney, J. Terry, L. Freese, and P. Fitzgerald. 1990. *J. Sugar Beet Res.* 27: (in press).

The collection and evaluation of wild germplasm has received increased attention in recent years due to the need for pest resistance genes and concern about extinction of germplasm through gradual elimination of natural habitats. This is particularly true of *Beta vulgaris* L. ssp. *maritima* (L.) Thell. (sea beet). A joint exploration between USDA-ARS; International Board of Plant Genetic Resources (IBPGR); Kew Botanical Gardens; Centre for Genetic Resources The Netherlands (CGN); and the Department of Agriculture of the Republic of Ireland for this taxon was conducted in 1987 along the coasts of England, Ireland and Wales. This exploration provided an opportunity to evaluate the distribution and dispersal of sea beet and to collect seed for preservation. The distribution of sea beet was similar to earlier observations. However, many small populations were in danger of extinction or had disappeared. Plants were most prevalent on shingle (gravel) beaches in a narrow band between high tide and 10 to 20 km inland. Factors threatening or causing extinction of local populations included livestock grazing

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Campbell, L. G. 1990. Registration of F1010 sugarbeet germplasm. *Crop Sci.* 30:429-430.

Campbell, L. G. and W. M. Bugbee. 1989. Inheritance of storage-rot resistance. *J. Sugar Beet Res.* 26:A4. (Abstract)

Campbell, L. G. and W. M. Bugbee. 1989. Registration of sugarbeet germplasm with combined storage rot resistance and low storage-respiration rate. *Crop Sci.* 29:836-837.

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Moser, H. S., G. A. Smith, and S. S. Martin. 1990. Sporophytic and gametophytic response of sugarbeet to two pathotoxins. *Crop Sci.* 30:1-6.

Smith, G. A. 1989. Sugarbeet research at the Fargo USDA Center. *The Sugarbeet Grower* 27:24-26.

Smith, G. A. and S. S. Martin. 1989. Effects of selection for sugarbeet purity components on quality and sucrose extractions. *Crop Sci.* 29(2): 294-298.

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CERCOSPORA RESISTANCE BREEDING AND RELATED RESEARCH
BSDF Project 600 (Formerly 250)

G. A. Smith and E. G. Ruppel

1989 Cercospora Nursery Research.--The 1989 Cercospora field research supported by BSDF Project 600 was conducted for the eighth year on Colorado State University land located west of the CSU Veterinary Research and Teaching Center. The Cercospora nursery was planted April 14. The nursery was inoculated on June 27 and July 8. Disease evaluations were conducted August 15, August 31, and September 5. On September 5, the mean leaf spot ratings of the resistant and susceptible checks were 3.25 and 6.25, respectively. These values compare with 4.0 and 7.0 for resistant and susceptible checks, respectively, in 1988. Forty-three of the 56 entries, or 76%, equaled or surpassed the resistant check for leaf spot resistance at the epidemic peak (Table 1).

Table 1. Mean leaf spot ratings of breeding lines at Fort Collins, Colorado, 1989. (BSDF Project 600, previously Project 250)

Entry No.	Seed No.	Description/Pedigree	Leaf Spot Rating*
1301	871028H02	FC 605 CMS X FC 502/3 T.O.	3.00
1302	871028H03	FC 607 CMS X FC 502.3 T.O.	2.50
1303	871032H02	FC 605 CMS X FC 506 T.O.	3.00
1304	871032H03	FC 607 CMS X FC 506 T.O.	2.75
1305	871033H03	761036H01 CMS X FC 605 T.O.	3.25
1306	871034H02	FC 502 CMS X FC 607 T.O.	2.75
1307	871034H06	652016 CMS X FC 607 T.O.	3.00
1308	871034H07	662119H01 CMS X FC 607 T.O.	2.75
1309	871034H09	FC 502 CMS X FC 607 T.O.	2.75
1310	871035H02	662119H01 CMS X FC 606 T.O.	3.00
1311	871038H0	FC609 T.O.	3.50
1312	871038H01	FC 609 CMS	3.00
1313	871046H01	3rd cy Rh fr (±FC 609 CMS X FC 708)	3.00
1314	871046H0	3rd cyc. Rh fr (±FC 609 X FC 708)	3.25
1315	861012H02	(FC 607 T.O., rr, mm X FC 701/4 97% R-mm) X FC 607 T.O., rr, mm BC3	3.00
1316	861016H0	FC 607 (4X) T.O. (C3)	2.75
1317	861016H01	FC 607 (4X) (C3)	2.25
1318	861017H0	FC 606 (4X) T.O. (C3)	4.25
1319	861017H01	FC 606 (4X) CMS (C3)	3.50
1320	861018H04	FC 607 CMS X FC 502/3 T.O.	2.75
1321	861019H02	FC 506 CMS X FC 607 T.O.	2.25
1322	861019H03	FC 502/3 X FC 607 T.O.	3.00
1323	861019H04	761036H01 CMS X FC 607 T.O.	3.25
1324	861019H05	662119H01 X FC 607 T.O.	3.00
1325	861020H02	FC 607 CMS X 662119H0	3.00
1326	861022H02	FC 605 CMS, mm X FC 502/2 T.O. mm	3.00
1327	861022H03	FC 504 CMS, mm X FC 502/2 T.O. mm	2.50
1328	861025H04	FC 607 CMS X 64010 T.O.	2.75
1329	861026H03	761036H01 CMS X FC 603 T.O.	3.25
1330	861026H04	652016 CMS X FC 603 T.O.	2.50
1331	851053H02	SP6323-01 CMS X FC 609 T.O. mm	5.00
1332	851057H04	FC 607 CMS X 721055 T.O.	3.25
1333	881018H02	FC 605 CMS, mm X FC 502/2, T.O. mm	2.75
1334	881018H03	FC 506 CMS, mm X FC 502/2, T.O. mm	2.50
1335	881019H2	761036H01 CMS, mm X FC 901, mm	3.75

Table 1. Continued.

Entry No.	Seed No.	Description/Pedigree	Leaf Spot Rating*
1336	881019H3	FC 607 CMS, mm X FC 901, mm	3.00
1337	881019H4	FC 609 CMS, mm X FC 901, mm	4.00
1338	881020H03	761036H01 CMS, mm X FC 603 T.O. mm	3.00
1339	881020H04	652016H01 CMS, mm X FC 603 T.O. mm	2.50
1340	881020H05	FC 607 CMS, mm X FC 603 T.O. mm	2.50
1341	821052	Yellow Leaf Mutant	6.50
1342	881021H02	FC 506 CMS, mm X FC 502 T.O. mm	2.75
1343	881021H03	FC 506 CMS, mm X FC 502 T.O. mm	2.00
1344	881022H04	FC 609 CMS, mm X FC 607 T.O. mm	3.00
1345	881022H05	761036H01 CMS, mm X FC 607 T.O. mm	3.00
1346	881022H06	652016H01 CMS, mm X FC 607 T.O. mm	2.50
1347	881007	4th cy Rh fr 3 comm Rh Hybrids	5.75
1348	881008	4th cy Rh fr 2 comm hybrids	3.50
1349	881012	1st cy Ry fr FC 712 x Mono 309	5.75
1350	881014	1st cy Ry fr FC 712 x Mono-Hy A4	3.00
1351	881030	Rh fr (FC701 x LSR-CTR)	3.25
1352	881031	2d cy Rh fr (FC708 x ACH 14)	3.25
1353	881033	FC 702/7	3.25
1354	A88-17	Mono Hy 55, Colo. Hyb.	4.50
1355	A88-18	Maribo 411, high qual, high sucrose	5.75
1356	A87-24	Mono Hy A7, (usn-23966)	4.00
1357	821051H02	LSR CHECK	3.25
1358	851060	LSS CHECK	6.50

*Leaf spot ratings based on 0 to 10 scale, with 0 = no symptoms and 10 = complete defoliation. Ratings presented were taken at the peak of the epidemic, September 5, 1989. LSD (P = 0.05) = 0.95.

Leaf Spot Evaluation of U.S.-Yugoslavian Crosses

G. A. Smith

As part of an ongoing PL-480 project, U.S. and Yugoslavian breeding lines have been crossed and evaluated under controlled artificial conditions at Fort Collins and under field conditions in Yugoslavia. Crosses in Table 1 were synthesized using only 2X pollinators and cms lines. These crosses were made using older U.S.-released parental lines and Yugoslavian lines which have shown leaf spot resistance. Five of the 24 crosses had leaf spot ratings below 4 compared to the long-term check of 3.43 (entry 28).

Triploid and diploid experimental hybrids were synthesized using more advanced U.S. and Yugoslavian lines (Table 2). All of the 2X and 3X hybrids from these crosses were significantly better (lower) than the leaf spot susceptible check (entry 1458). All of the crosses were statistically equal to the resistant check. The four 3X hybrids had a mean leaf spot rating of 3.62 *vs.* 3.12 for the ten 2X hybrids, which is not statistically different.

This test demonstrates that maximum resistance to leaf spot is achieved in hybrids where both parents have been developed for Cercospora resistance (a fact we have observed many times). This result occurs irrespective of final ploidy level of the hybrids.

Table 1. Mean leaf spot ratings of U.S. - Yugoslavia crosses using 2X pollinators and cms lines.

Entry No.	Seed Description	Rating[a]	Leaf Spot % of Check[b]
1	NS-1223MS-H X FC 901	4.86	107
2	NS-100 500/86MS-H X FC 702/6	4.50	99
3	NS-1103-3MS-H X FC 901	4.52	100
4	NS-A100 500/86MS-H X FC 901	4.81	106
5	NS-5/1/85MS-H X FC 702/6	4.71	104
6	NS-1223MS-H X FC 702/6	4.90	108
7	NS-1103MS-H X FC 702/6	4.52	100
8	NS-5/1/85MS-H X FC 702/6	5.19	114
9	FC 605H X F2500	3.79	83
10	FC 605MS-H X RT	4.79	105
11	FC 605MS-H X HC	4.71	104
12	FC 605MS-H X 6P	3.48	77
13	FC 502/3MS-H X HC	4.14	91
14	FC 502/3MS-H X RT	4.29	94
15	FC 502/3MS-H X F2500	3.86	85
16	FC 502/3MS-H X 6P	3.90	86
17	FC 504MS-H X 6P	4.33	95
18	FC 504H X F2500	4.24	93
19	FC 504MS-H X RT	4.19	92
20	FC 504MS-H X HC	4.10	90
21	FC 506MS-H X RT	4.71	104
22	FC 506-H X F2500	4.10	90
23	FC 506MS-H X HC	4.29	94
24	FC 506MS-H X 6P	3.71	82
25	9BV5315 Beta 5315 (8023)	3.67	81
26	9CHECK2 Hill 5135 (801524)	4.81	106
27	9CHECK3 EDDA NEWSTD3	5.14	114
28	821051H2 LSR CHECK	3.43	76
29	851060 LSS CHECK	4.57	101

[a]Mean of 7 ratings taken between July 17 and August 17. Ratings based on 0 to 10 scale. 0 rating = no symptoms, 10 rating = complete defoliation. NS = Yugoslavian lines; FC = U.S. lines.

[b]% of check = % of average of entries 25, 26, and 27.

Table 2. Mean leaf spot ratings of U.S.-Yugoslavia crosses using 2X and 4X U.S. and Yugoslavian pollinators. (PL-480 Project)

Entry No.	Seed No.	Description[a]	Mean Leaf Spot Rating[b]
1437	881040H2	FC 607 CMS, (2X), mm X NS-2485/85, (2X),mm	3.50
1438	881040H3	FC 606 CMS, 2X, mm X NS-2485/85, (2X),mm	3.00
1439	881040H4	FC 502 CMS, (2X), mm X NS-2485/85, (2X),mm	2.75
1440	881040H5	FC 603 CMS, (2X), mm X NS-2485/85, (2X),mm	3.25
1441	A79-67	FC 607 (2x), mm, T.O.	3.00
1442	871003H02	NS-6A84, (2X), mm, CMS X FC 607 mm, T.O.	3.25
1443	871003H04	NS-MS100, (2X), mm, CMS X FC 607 mm, T.O.	3.00
1444	781035H0	FC 606 mm, CMS	3.25
1445	871004H02	NS6A84, (2X), mm, CMS X FC 606 mm, T.O.	3.25
1446	871004H05	NS-62MS, (2X), mm, CMS X FC 606 mm, T.O.	3.00
1447	841042H0	FC 606 (4X), mm, T.O.	3.25
1448	871005H02	NS-6A84, (2X), mm, CMS X FC 606 (4X), mm, T.O.	3.50

Table 2. Continued.

Entry No.	Seed No.	Description[a]	Mean Leaf Spot Rating[b]
1449	871005H05	NS-62MS, (2X), mm, CMS X FC 606 (4X), mm, T.O.	4.00
1450	841040H0	FC 607 (4X), mm, T.O.	3.25
1451	871006H02	NS-6A84, (2X), mm, CMS X FC 607 (4X), mm, T.O.	3.75
1452	871006H05	NS-62MS, (2X), mm, CMS X FC 607 (4X), mm, T.O.	3.25
1453	A86-43	NS-F-658, (2X), MM	3.50
1454	A86-44	NS-2485/85, (2X), MM	3.25
1455	871008H2	FC 607 CMS, (2X), mm X NS-2485/85, (2X), mm	3.25
1456	871008H3	FC 606 CMS, (2X), mm X NS-2485/85, (2X), mm	3.00
1457	821051H2	LSR CK	3.00
1458	851060	LSS CK	6.00

[a]NS = Novi Sad Yugoslavia; FC = Fort Collins.

[b]Leaf spot ratings based on 0 to 10 scale, with 0 = no symptoms and 10 = complete defoliation. Ratings presented were taken at the peak of the epidemic, September 5, 1989. LSD (P = 0.05) = 1.12.

COMBINING ABILITY OF HIGH LEAF SPOT RESISTANT U.S. LINES AND HIGH SUGAR 4X EUROPEAN LINES

G. A. Smith and L. G. Campbell

It is often contended that hybrids with high leaf spot resistance will not yield as well under conditions of no leaf spot. The results presented here would tend to refute that contention.

FC 607, our most leaf spot resistant line, was crossed to ten (4X) pollinators developed in Northern Europe for high sucrose yield combining ability. Yield tests of these triploid hybrids along with appropriate checks were evaluated, under non-leaf spot conditions, at Fargo, North Dakota. Evaluation for leaf spot resistance was conducted at Fort Collins, Colorado, under uniform field epidemic conditions. Although severe drought at the Fargo location reduced sucrose yields considerably, several of these triploid hybrids were equal to or greater than the commercial cultivar check for root yield and for extractable sucrose per acre (ESPA). Several of the more leaf spot resistant hybrids (e.g. entries 1533, 1535, 1537, and 1538) were among the best for ESPA under the non-leaf spot conditions (Table 1).

Table 4. Triploid combining ability evaluation of FC607 for yield, sucrose, and leaf spot resistance (BSDF Project 600 - Previously Project 250).

Entry No.	Seed No.	Description/Pedegree	Leaf Spot Rating[a]	% Sucrose	Tons	Purity	ESPA[b]
1531	AF89-1	FC 607 CMS (2X) X European 4X	5.00	11.3	25.3	90.6	4582
1532	AF89-2	FC 607 CMS (2X) X European 4X	5.00	10.9	24.2	89.2	4104
1533	AF89-3	FC 607 CMS (2X) X European 4X	4.00	11.7	22.8	91.2	4360
1534	AF89-4	FC 607 CMS (2X) X European 4X	4.50	10.6	21.0	88.8	3397
1535	AF89-5	FC 607 CMS (2X) X European 4X	4.00	11.0	25.0	89.7	4275
1536	AF89-6	FC 607 CMS (2X) X European 4X	3.50	11.6	19.6	91.3	3738
1537	AF89-7	FC 607 CMS (2X) X European 4X	3.50	11.3	23.8	89.8	4236
1538	AF89-8	FC 607 CMS (2X) X European 4X	4.00	10.9	26.4	89.0	4443
1539	AF89-9	FC 607 CMS (2X) X European 4X	3.50	10.5	23.9	89.6	3935
1540	AF89-10	FC 607 CMS (2X) X European 4X	3.00	10.6	22.4	89.0	3638
1541	A79-68	FC 607 CMS 2X	2.75	10.8	14.3	90.0	2443
1542	871038H01	FC 609 CMS	3.00	10.0	14.2	89.9	2242
1543	841040H01	FC 607 CMS 4X	3.00	10.5	12.6	88.4	1998
1544	A87-1	Monohikari	5.25	12.0	22.5	91.4	4450
1545	821051H02	LSR CHECK	3.00				
1546	851060	LSS CHECK	6.25				
		Beta-6625		11.5	22.3	89.8	4019
		Ultramono		11.1	23.6	89.7	4137
LSD (0.05)		1.23	0.5	3.8	1.3	652	

[a]Leaf spot ratings based on 0 to 10 scale, with 0 = no symptoms and 10 = complete defoliation. Ratings presented were taken at the peak of the epidemic, September 5, 1989.

[b]ESPA = Extractable Sugar Per Acre.

NOTE: All yield traits were taken under non-leaf spot conditions. Entries were evaluated in a separate test for leaf spot.

RHIZOCTONIA ROOT ROT RESEARCH

BSDF Project 610 (Formerly 980) and Other Research

W. M. Bugbee

Pectin lyase, an enzyme produced by *Rhizoctonia solani*, has a major role in causing root rot. This report summarizes the past year's research on pectin lyase (PNL) from *Rhizoctonia solani* and a preformed protein in sugar beet that inhibits the activity of pectin lyase (PNLi). The objective of the research is to accumulate basic information that will guide future efforts to enhance crown and root rot resistance.

Amendment of Cell Suspensions with PNL.--The objective of this project is to develop a method to quickly select root-rot-resistant plants through tissue culture. Surviving cells that are exposed to lethal doses of PNL regenerate into whole plants that also are resistant to the enzyme as well as the fungus. Cell suspensions of root-rot-resistant FC 712 were more resistant to PNL than were suspensions of susceptible Ultramono lending support to the potential usefulness of this screening technique. Cell suspensions of the regenerative tissue culture line REL-1 were exposed to PNL. Treated suspensions with approximately 50% cell mortality after exposure to PNL were transferred to solid growth medium for callus production. Callus recovery, growth and greening was very slow initially. Currently, growth of the treated calli is normal but shoot initiation has not occurred. Increased dosages of benzyladenine and triiodobenzoic acid are being used to induce shoot formation.

Purification of PNLI.--An inhibitor of PNL, preformed in sugar beet roots (PNLi), has been purified to near homogeneity in a two-step process. In step one, a desalted ammonium sulfate fraction of root extract was loaded on a column of cyanogen bromide activated sepharose to which had been coupled PNL. The PNLi was retained on the column, presumably bound to the PNL. Unbound protein was washed off and the bound PNLi was eluted in a NaCl gradient. In step two, active PNLi fractions were pooled, concentrated by ammonium sulfate precipitation and fractionated further by molecular sieving. Four active fractions of different weights eluted from the column. Analyses by gel electrophoresis and isoelectric focusing of the final preparations has not been completed. Cation exchange chromatography and preparative isoelectric focusing are being tested for optimization of the process and to increase the yield of PNLi.

Development of Root Rot Influenced by pH.--Healthy sugar beet root tissue is about Ph 6.8, a pH favorable for maximum PNLi activity. The pH of crown and petiole tissue rotted by *R. solani* AG 2-2 increases to pH 7.0 to 8.2, a range favorable for maximum PNL activity but unfavorable for PNLi activity. Rot progresses more slowly when reaching the below-ground portions of the root. These below-ground rotted tissues have a pH of about 4.5 to 5.5, again unfavorable for PNL activity. The upward shift in pH of rotted crown tissue may partially account for the more rapid progress of rot in the crown than in the root by the AG 2-2 strain of *R. solani*.

Because of this pH effect, it was theorized that root rot would progress more rapidly in roots grown in alkaline soil than in acid soil. Sugar beets were grown in the greenhouse in soils from Crookston, MN (pH 8), Fargo, ND (pH 7.2) and Perham, MN (pH 6.2). Two-month-old plants were inoculated with *R. solani*. Wilt symptoms developed sooner on plants in the alkaline Crookston and Fargo soils than in the acid Perham soil. Roots were harvested and percent rot by weight was measured. There was no difference in rot development among the soil types even though wilt began sooner in the alkaline than in the acid soils. This experiment should be repeated in the field before final conclusions are drawn regarding the effect of soil pH on root rot development.

Content of Pectin Lyase Inhibitor in Tissues.--The amounts of PNLi in the crown, hypocotyl and roots of root-rot-resistant FC 712 and susceptible Ultramono were determined for 12 greenhouse-grown roots and eight field-grown roots. The three tissue types of Ultramono did not differ significantly in the amount of PNLi. There was an increase in PNLi from crown to root in FC 712 but the data were not significantly different. The PNLi content was significantly higher in FC 712 than Ultramono when all three tissue assays were combined in the statistical analysis.

Pectin Lyase Activity in the Presence of a Pectin Lyase Inhibitor.--The objective was to determine if slices of root tissue could be protected by PNLi from damage caused by PNL. Root discs were placed in distilled water (DW) and incubated 24 hours with PNL or PNL plus PNLi. Hexose sugars were measured in the DW as an indicator of damage after incubation because PNL destroys the semi-permeability of cell membranes to allow leakage of cell contents. The results of four trials showed 40% less leakage of hexoses from tissue treated with PNL plus PNLi than from tissue treated with PNL alone. This indicated that PNLi provided partial protection of living root tissue from damage caused by PNL. The significance of these findings is partial proof that PNLi plays a role in the sugar beet's biochemical mechanism of resistance to *R. solani*.

Monoclonal Antibodies Against Pectin Lyase Inhibitor.--Thirty-two hybridoma cultures positive for antibodies against PNLi have been produced. However, at the cloning stage there were no positive cultures, therefore the original hybridomas, retrieved from frozen storage, are being tested against purified PNLi. One practical use of a monoclonal antibody to PNLi is the quick, quantitative detection of genotypes producing PNLi (monoclonals in cooperation with Dr. Dave Gabrielsen, Department of Microbiology, North Dakota State University).

IN VITRO SELECTION, REGENERATION AND OTHER RESEARCH

BSDF Project 601 (Formerly 750)

G. A. Smith and J. D. Eide

Selection for Cercospora Resistance.--Tissue culture is being used for rapid selection of *Cercospora* resistance cell lines. Callus derived from FC 607 T.O. and FC 609 T.O. petiole tissue was forced through a 520 μ screen, rinsed, and placed in cell suspension media. Rose bengal and paraquat were used as challenging agents. These compounds mimic the oxygen radical formation of cercosporin toxin and are readily soluble in aqueous solutions. Actively growing suspension cultures in callus were placed in 1 μg or 10 μg/ml of rose bengal or paraquat for 6 or 18 hours. Cell viability was determined by staining with Evans blue. Rinsed cells were placed on shoot producing media. The optimum concentrations and exposure time are being determined.

Callus Production and Maintenance.--A rapid method of callus formation is needed for starting of suspension cultures. Comparisons of callus production from petioles or leaf blades were examined. Callus formation was enhanced using petioles (Table 1).

Maintenance of regenerative callus is difficult. Thidiazuron was examined as a growth regulator for use in maintaining regenerative callus (Table 2). Callus production was enhanced using 1.25 mg/l thidiazuron *vs.* 6-benzyl-aminopurine (BAP) as the plant growth regulator. Twelve lines were maintained and transferred every three weeks. Callus was readily available for starting suspension cultures for phytotoxin selection.

Table 1. Callus initiation and growth from 0.5 cm petiole segments as a result of cytokinin treatment. (Media = MS + 1.25 mg/L TDZ, or +1.0 mg/L BAP)

	Treatments			
	1.25 mg/L TDZ		1.0 mg/L BAP	
Callus Line	# calli	# >1 cm	# calli	# >1 cm
OV6c	2.5±1.2	1.2±0.9	1.1±1.3	0.2±0.4
OV7sh	2.9±0.9	0	0.2±0.6	0
OV8	3.4±2.0	0.2±0.6	0.3±0.4	0

Table 2. Callus initiation and growth from 0.5cm^2 leaf blade segments on MS + 1.25 mg/L TDZ or 1.0 1.0 mg/L BAP.

	Treatments			
	1.25 mg/L TDZ		1.0 mg/L BAP	
Callus Line	# calli	# >1 cm	# calli	# >1 cm
OV6c	1.8±1.5	0.2±0.4	0.6±1.3	0
OV7sh	1.9±1.3	0.2±0.4	1.6±0.6	0.1±0.3
OV8	3.8±3.1	0	0	0

Clone Bank.--Cloned sugarbeets were maintained or started to facilitate rapid propagation of sugarbeet lines. A total of 53 cloned lines were maintained on shoot media. Clones were transferred every 3 to 4 weeks. Root production has been accomplished after 18 subcultures.

Haploid Production and Maintenance.--Ovule culture was used for the production of homozygous callus lines. We have been able to regenerate some of these callus. Plants regenerated from ovule callus were produced and maintained for production of cell suspension cultures. Chromosome counts of these regenerated lines have been haploid, diploid, triploid, and tetraploid. Doubled haploids lines have no masked recessive genes and thus are useful in toxin selection schemes.

Biological Control of Sugarbeet Root Maggot.--The following report is a summary of preliminary research associated with a newly funded major research project for development of a biopesticide for sugarbeet. The major research of this project will begin as soon as the research team is completed, which will be about July 1990.

Sugarbeet root maggots, *Tetanops myopaeformis* (von Röder), cause considerable damage to sugarbeets in many areas of the country. Use of pesticides to control the maggot infestations are less effective due to an increase in resistance. The threat of groundwater contamination and the general public fear of chemical use may further limit new pesticides for maggot control. We have initiated research into biological control of the maggot using *Bacillus thuringiensis*. Our ultimate objective is transformation of sugarbeet endophytic bacteria using a toxin producing gene.

Sugarbeet root maggot belongs to the order Diptera. We have acquired a bacteria [*B. thuringiensis* var. *israelensis* (ATCC#35646)] that produces a δ-endotoxin which is toxic against certain dipteran larvae. Once transformation is accomplished, the transformed bacteria will need to be "taken up" by the plant.

To determine if the bacteria could be recovered in the seed and subsequent seedlings, we sprayed flowering sugarbeets with 10 ml of 0.5, 1.0, and 10.0 million *B. thuringiensis* var. *israelensis* per ml every 2 to 3 days for 8 days. Harvested seed was surface sterilized and ground with a mortar and pestle. Serial dilutions were performed and plated onto bacteria media. The total number of bacteria per 20 seeds was determined.

Bacteria in the seed were identified by the following criteria: colony morphology; gram stain test; biochemical utilization of glucose, arabinose, xylose, mannitol, casein, starch, and gelatin; and production of catalase.

Large variations in bacterial numbers were determined (Figures 1 and 2). Of these bacteria, only a small number of *B. thuringiensis* bacteria were identified (Figure 3).

Seed from the above experiments was surface sterilized and planted in sterile potting soil. Three- to four-week-old leaf or root material was surface sterilized and assayed for endophytic *B. thuringiensis*. Large numbers of bacteria were present (data not shown). Screening these large numbers of bacteria will necessitate the cloning of an ampicillin antibiotic marker gene into the *B. thuringiensis* plasmid carrying the δ-endotoxin. Ongoing experiments will determine the surface or endophytic concentrations needed for sugarbeet maggot control.

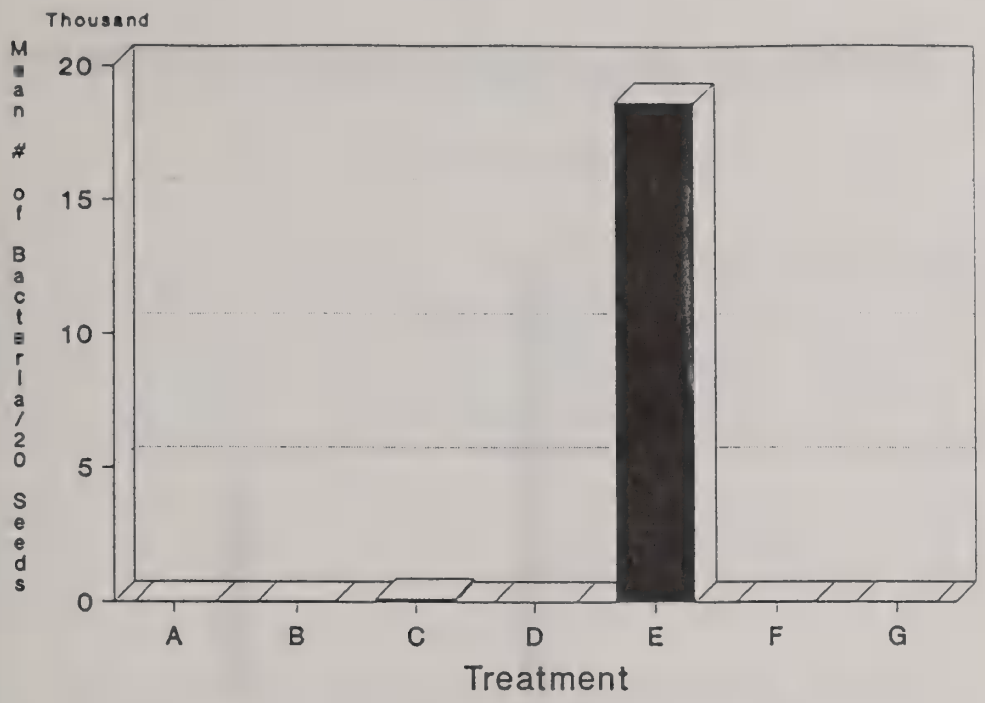

Figure 1. Mean number of endophytic bacteria per 20 seeds with 10 replications per treatment. Flowering plants sprayed with A,B,F,G sterile phosphate buffer; C, 0.5 X 10^6 B. thuringiensis per ml; D, 1.0 X 10^6 B. thuringiensis per ml; E, 10.0 X 10^6 B. thuringiensis per ml.

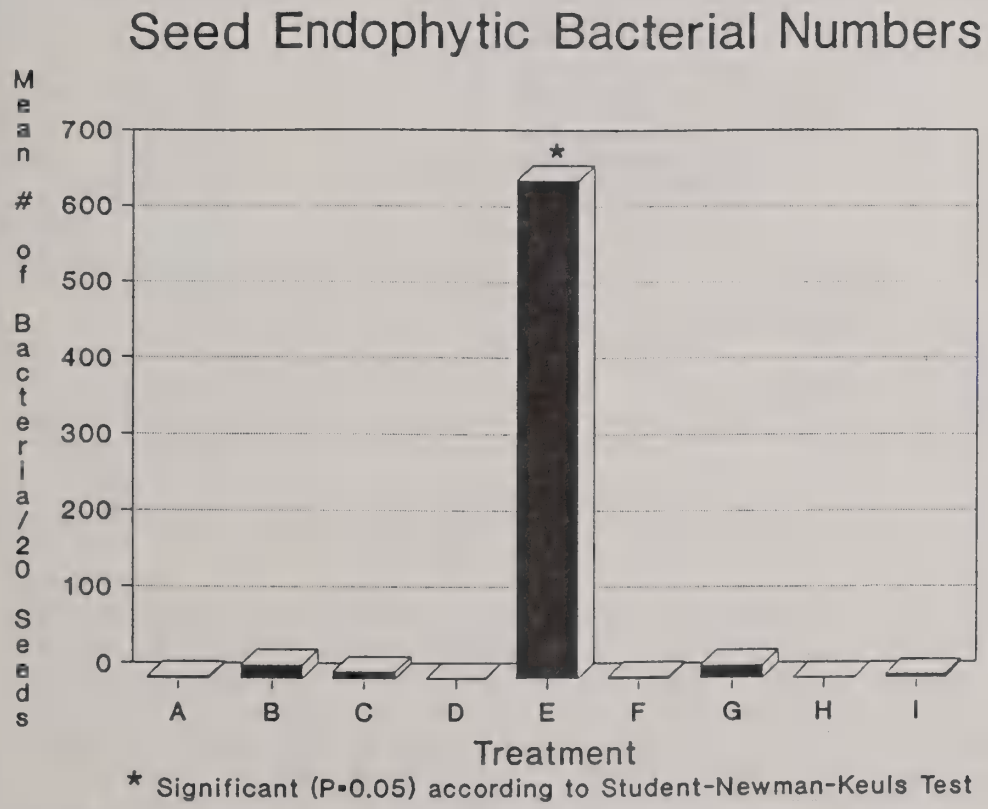

Figure 2. Mean numbers of endophytic bacteria per 20 seeds with 5 to 10 replications. Flowering plants sprayed with A,E 0.5 X 10^6 B. thuringiensis per ml; B,F 1.0 X 10^6 B. thuringiensis per ml; D,H,I sterile phosphate buffer.

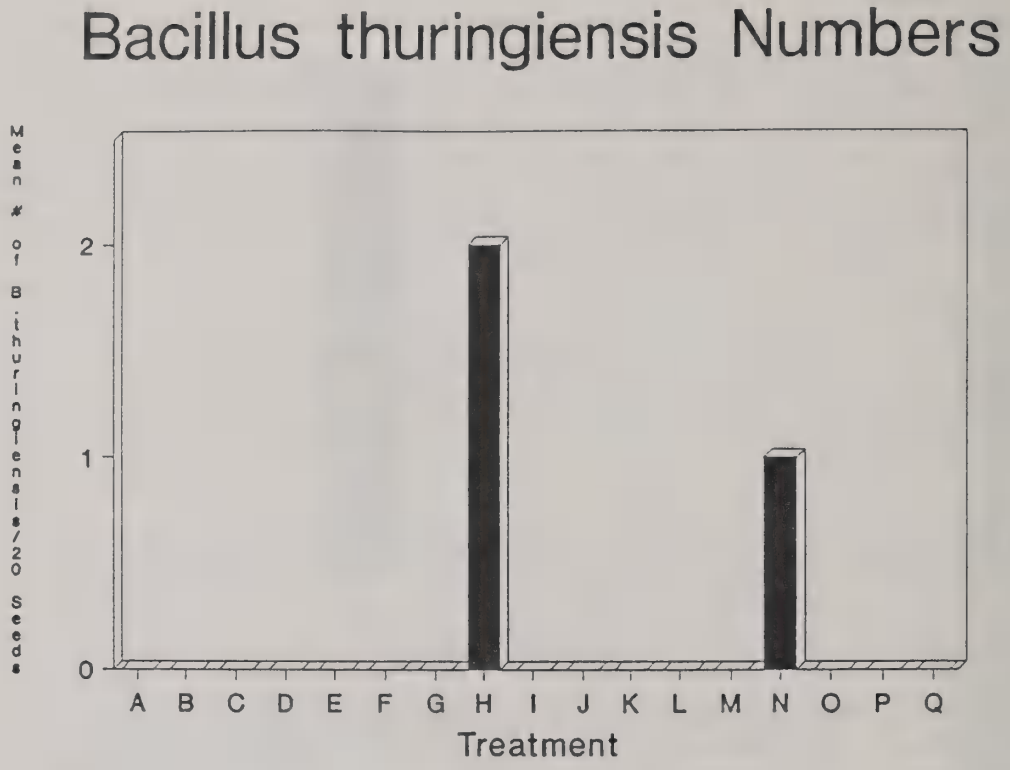

Figure 3. Mean number of B. thuringiensis per 20 seeds. Flowering plants sprayed with A,B,F,G,K,O,P sterile phosphate buffer; C,H,L 0.5 X 10^6 B. thuringiensis per ml; D,I,M 1.0 X 10^6 B. thuringiensis per ml; E,J,N 10.0 X 10^6 B. thuringenesis per ml.

SUGARBEET ROOT MAGGOT RESISTANCE AND SELECTION FOR SUCROSE YIELD

BSDF Project 620 (Formerly 930)

L. G. Campbell

Root Maggot Resistance Breeding.--The sugarbeet root maggot (*Tetanops myopaeformis*) is the major insect pest in the Red River Valley. Traditionally this pest has been controlled by insecticides applied at planting. Effective genetic resistance to this organism would reduce the need for insecticide applications and its associated costs. Genetic resistance would be especially beneficial if some of the widely used insecticides are removed from the market because of their suspected effects upon the environment.

Attempts to identify resistant genotypes have been only marginally successful. The first efforts to isolate resistance were conducted in Utah - Idaho. A few years ago this effort was transferred to North Dakota where various populations and breeding lines have been selected under natural maggot infestations near St. Thomas, North Dakota.

Figure 1 documents the progress observed to date. Damage ratings are reported on a zero to five scale with zero being no observed maggot damage and five representing severe damage. The breeding lines with the "L-" designations were selected for maggot resistance in Idaho for a number of generations and have since been screened at St. Thomas. These lines are the most resistant material available. The other breeding populations have been selected for two to four cycles at St. Thomas and exhibit only low levels of resistance, compared to the commercial hybrids. This is indicative of the slow progress generally observed in selecting for maggot resistance. The three best breeding lines (L-3, L-8, and L-10) had an average damage rating of 2.2 compared to a damage rating of 3.5 for the five commercial hybrids. While this level of damage is not as low as desired for commercial production it approaches the control level obtained with insecticides at the same test location (Figure 2). Over a five year period (1984 - 1988) insecticide treated plots had an average damage rating of 1.5 compared to 3.4 for the untreated plots. Insecticidal control was variable from year to year; for example, control was considerably better

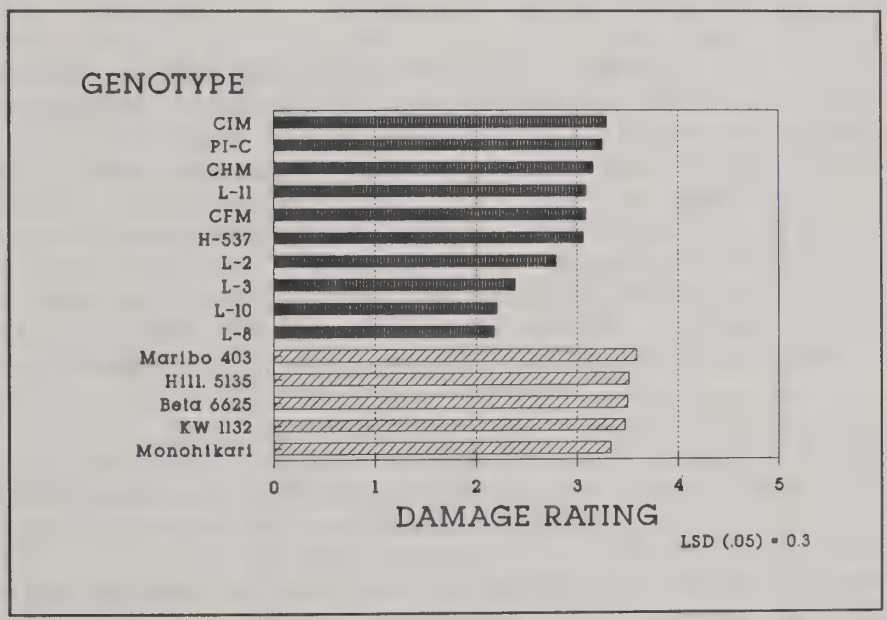

Figure 1. Sugarbeet root maggot damage ratings St. Thomas, North Dakota 1989 (0 = no damage to 5 = severely damaged).

in 1984 and 1986 than in 1988. This suggests that if current pesticides were removed from the market the presently available genetic resistance could provide a useful level of control, comparable to that obtained with insecticides. However, because of the difficulty and time involved in transferring resistance to each company's elite parental lines, this resistance source probably would not be widely used. Both the seed parent and the pollinator of a commercial hybrid would need to have resistance for effective control in commercial production. A resistant tetraploid pollinator would increase the genetic contribution of the pollinator and might result in a moderate level of control. The most resistant diploid breeding lines are being converted to tetraploid lines and will be evaluated as tetraploid pollinators. The USDA/ARS sugarbeet research unit is beginning the process of developing a biopesticide to control the sugarbeet root maggot. If a future biopesticide provided less than complete control of the maggot it is conceivable that the combined effects of the biopesticide and genetic resistance would provide effective control for commercial production.

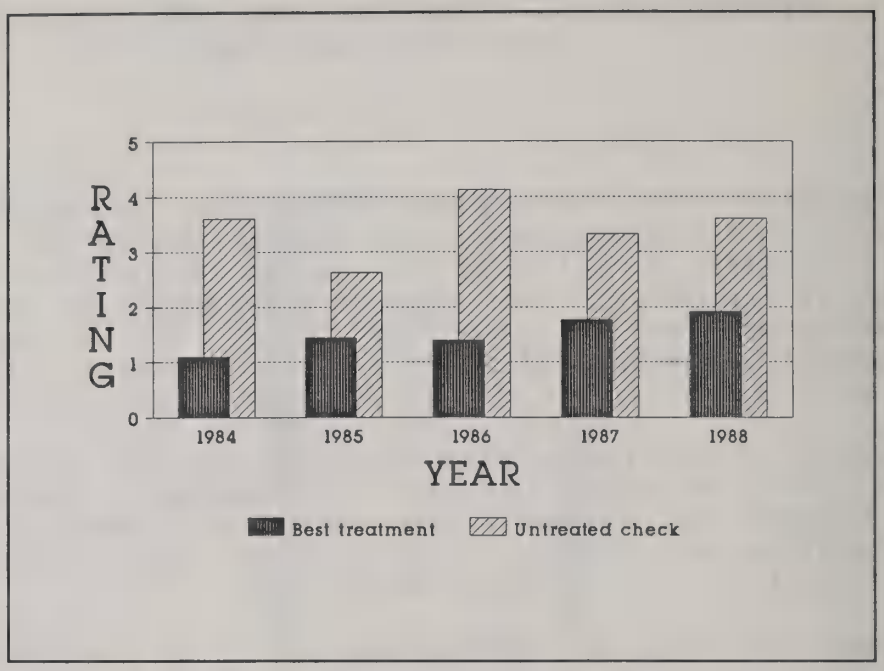

Figure 2. Sugarbeet root maggot damage ratings St. Thomas, North Dakota 1984-1988. Most effective insecticide versus untreated check (0 = no damage to 5 = severely damaged).

Suscrose Selection from the USDA Collection.--The USDA *Beta vulgaris* collection apparently has not been used extensively in breeding programs and, thus, may provide unique genetic combinations for increased root yield and sucrose concentration as well as increased genetic diversity. This collection was used as a source population in a selection program with the objective of extracting agronomically desirable germplasm from a previously untapped source.

One hundred sixty-seven accessions of the *B. vulgaris* collection (NC-7) maintained by USDA-ARS at Ames, Iowa, were evaluated for sucrose concentration. All accessions exhibited biennial growth habit and some were non-sugarbeet types or mixtures. The choice of accessions was limited to entries with sufficient seed for field planting. The sucrose concentration of each root was determined on a tissue sample obtained by drilling a 1.25 inch diameter hole in the taproot with a power drill. Samples were frozen immediately and subsequently analyzed for sucrose concentration using standard tare laboratory procedures. Because of limited seed supplies, the original accessions

were evaluated in unreplicated field plots with a commercial high sucrose hybrid (ACH-14) in every fifth plot.

Twenty-six accessions with relatively high sucrose concentrations were identified. Four to six roots with relatively high sucrose concentration from each accession were induced to flower and were interpollinated within an accession. Progeny were evaluated in replicated field plots. Individual roots with high sucrose concentration from lines with high sucrose concentration were induced to flower and crossed in pairs within a line. Four additional cycles of mass selection within each line formed by a pair-cross followed. High sucrose individuals from desirable lines were selected in all selection cycles except the fifth. Fifth cycle selection was based solely upon line performance and a random sample of individuals from selected lines provided seed for the sixth cycle. Approximately ten plants per line were increased for each cycle. Root yield was added as a selection criterion in the last three selection cycles. Visual selection eliminated severely sprangled or colored roots. Four germplasms, F1011 - F1014, were selected in this manner.

Both F1011 and F1012 were selected from PI266100, an accession from Poland. F1013 was selected from PI169025, an accession that originated from Turkey, and F1014 from PI355959 from Russia. F1012, F1013, and F1014 segregate for pink and green hypocotyl color. F1011 has pink hypocotyls. All four lines are diploid and produce multigerm seed. In the initial screening the original four accessions were from 1.5 to 2.2% lower in sucrose concentration than ACH-14. Also, comparisons of the parental accessions with F1013 and F1014 indicated that selection had increased sucrose concentration approximately 2.5%. Average sucrose concentration of the four germplasms was equal to the sucrose concentration of the commercial hybrids used as checks (Table 1). Yield differences were not significant in all cases but, in general, root yields were about 75% of that observed for the hybrids. F1011 and F1012 originated from the same parental accession but exhibited contrasting performance throughout the selection and testing process. F1011 had consistently high sucrose concentration while F1012 was consistently one of the higher yielding lines. F1013 and F1014 appeared to be intermediate in both root yield and sucrose concentration. Purity of all the germplasms was not substantially different than that observed for the commercial hybrids. Purity increased as the sucrose concentration was increased so purity was not included as a selection criterion. The low root yields in 1986 were the result of waterlogged soil conditions shortly after emergence.

These germplasms make readily available a portion of the genetic diversity within the USDA *Beta* collection. All are intended to provide unique genetic sources for the development of populations and parental lines with enhanced performance. Preliminary combining-ability tests that are underway will provide insight into the potential value of these germplasms. Since selection was almost exclusively for sucrose concentration and root yield, commercial breeders likely will need to introduce genetic resistance to the pests unique to their regions by combining their elite breeding populations and these germplasms. The described germplasms were developed and released jointly by the Agricultural Research Service, USDA and the North Dakota Agricultural Experimental Station.

Table 1. Performance of sugarbeet germplasms, Fargo, North Dakota, 1985-1988.

Designation	Sucrose			Root yield			Purity	
	1985	1986	1988	1985	1986	1988	1986	1988
	---------- % ----------			------- tons/acre --------			----- % -----	
F1011	17.3	15.3	15.1	13.7	6.3	11.7	94.5	93.0
F1012	16.5	14.4	13.9	15.8	8.3	16.3	94.7	91.5
F1013	16.5	14.0	12.6	15.0	7.1	14.7	93.0	89.2
F1014	16.0	13.9	13.3	15.6	5.4	8.4	92.3	91.5
Mean	16.6	14.4	13.7	15.0	6.8	12.8	93.6	91.3
ACH-164	16.4	14.6	13.9	14.5	10.4	17.2	94.4	91.2
Ultramono	16.3	14.1	13.8	19.4	10.2	16.9	94.4	91.0
Beta 1230	16.1	13.8	13.4	17.8	10.2	19.8	93.7	90.0
Monohikari	--	--	13.8	--	--	16.2	--	--
Mean	16.3	14.2	13.7	17.2	10.3	17.5	94.2	90.7
$LSD_{0.05}$	1.1	1.0	0.6	2.6	2.7	1.6	3.0	1.0

PHYSIOLOGICAL SELECTION AND GERMPLASM RESEARCH

BSDF Project 630

D. L. Doney

Stress Selection.--For several years I have been evaluating a new selection criterion (Stress Selection). The approach is to exert severe stress on sugarbeet seedlings such that only those that store sucrose early and are efficient in respiration survive. Survivors are open-pollinated to generate a new selection population. Pilot field trials suggested moderate progress in both root yield and sucrose concentration but that several cycles of selection will be necessary to identify true increases.

Several populations have now been advanced to two and three cycles of stress selection. The first field trials of these advanced selection cycles were conducted this past summer (Table 1).

Table 1. Root yield, sucrose percentage, gross sugar and recoverable sugar for stress selection populations and check cultivars.

Test 1						Test 2					
Code	Description	Root Yield	Sucrose	Gross Sugar	Recoverable Sugar	Code	Description	Root Yield	Sucrose	Gross Sugar	Recoverable Sugar
		T/A	%	Lbs/A	Lbs/A			T/A	%	Lbs/A	Lbs/A
s153s1	2nd cycle	20.75	13.52	5607	5468	r528s1	1st cycle	20.32	11.43	4645	4518
						r528s3	3rd cycle	23.06	11.52	5317	5159
r512s1	1st cycle	17.30	12.49	4325	4213						
r512s2	2nd cycle	19.71	12.49	4919	4794	r22s1	1st cycle	18.44	13.30	4921	4795
						r22s2	2nd cycle	18.25	13.67	4993	4873
r513s1	1st cycle	18.25	11.97	4367	4245	r22s3	3rd cycle	19.00	13.51	5136	5009
r513s2	2nd cycle	19.10	12.15	4635	4510						
H5135	check	18.20	15.21	5544	5412	H5135	check	19.37	15.28	5923	5793
ACH164	check	19.92	14.67	5853	5708	ACH164	check	18.34	14.91	5471	5339
Ultramono	check	16.97	14.72	4995	4876	Ultramono	check	17.77	14.83	5281	5156
LSD 0.05		2.37	0.30	624	607	LSD 0.05		2.06	0.35	582	568
CV %		15.43	2.61	15.4	15.3	CV %		12.05	3.04	13.0	13.0

The selection populations in Table 1, Test 1 (s153, r512 and r513) are pair crosses from the same original population advanced to the first ('s1') and second ('s2') selection cycles. There were insufficient seed to test the first selection cycle of population s153; however, the second selection cycle population (s135s2) performed well. Its recoverable sugar per acre was 103% of the check varieties (Table 1). It was, however, low in sucrose concentration.

The second cycle selection (r512s2) of population r512 showed a significant increase in root yield and recoverable sugar over the first cycle (r512s1). The sugar percentage, however, was not different. The second cycle selection (r513s2) of population r513 exhibited nonsignificant increases in root yield, sucrose percentage, and recoverable sugar over the first cycle (r513s1). Recoverable sugar, as percent of the check varieties, increased from 79 to 90% for population r512 and from 80 to 85% for population r513 from the first to the second cycles of selection.

The two populations (r528 and r22) in Table 1, Test 2, are from entirely different sources. The r528 original population was low in sucrose concentration and high in root yield. The second cycle selection of this population was not tested because of insufficient seed. Both populations were advanced to the third cycle of stress selection. Significant increases in root yield and recoverable sugar and nonsignificant increases in sucrose percentage were observed in population r528 as selection advanced from the first to the third cycle (Table 1, Test 2). Increases in root yield, sucrose concentration and recoverable sugar were recorded for each succeeding selection cycle in population r22; however, increases were small and nonsignificant. Recoverable sugar, as percent of the check varieties, increased from 83 to 95% and from 88 to 92% between the first and third selection cycles of the two populations, respectively.

These tests tend to substantiate earlier pilot tests. This stress selection approach appears to put selection pressure on recoverable sugar without adversely affecting sucrose concentration. The root yield component of recoverable sugar appears to be affected more than sucrose concentration, however; in no test was the sucrose concentration decreased as root yield increased.

Green Leaf Duration.--In cereals, the green leaf duration of the flag leaf has been found to be associated both physiologically and genetically with grain fill and ultimately grain yield. The longer the source of photosynthate supply is active the longer the grain fill and the larger the grain yield.

We have found a similar relationship between root yield and the life span (days from planting to death) of the first true leaves. This relationship suggests that the longer green leaves remain photosynthetically active the more photosynthate is supplied to the root.

This past year we developed a selection stratagem to select for green leaf duration of the first true leaves. Selection was conducted in a very heterogeneous population. Plants were grown under uniform conditions (emergence, nutrition, light and temperature) in the growth chamber. The first true leaves were monitored and data taken on the day of initiation and day of senescence. The day necrotic tissue first appeared on yellowed leaves was identified as the day of senescence.

Plants whose first true leaves reached senescence first were open-pollinated to produce population v763 (first), whereas those plants whose first true leaves were the last to senescence were combined to produce open-pollinated population v762 (last). These two populations along with Hilleshög 5135 (check) were tested in the growth chamber for leaf initiation and senescence of the first true leaves (Table 2).

Table 2. Date of first true leaf initiation, age of first true leaves at senescence, and days from emergence to senescence of the first true leaves for selections for first and last senescence and a check cultivar.

Genotype	Date of leaf initiation	Age of leaf to senescence	Emergence to senescence
V763	3.96	20.31	24.27
V762	3.96	22.32	26.26
H5135 (check)	3.56	23.25	26.83
L.S.D. P = 0.05	0.22	0.53	0.51

The time of leaf initiation of the two selection populations was identical, whereas the check cultivar began leaf initiation earlier. The green leaf duration (age of the first true leaves at the time of senescence and the age of the plants at the time of senescence) of population v762 (last) was two days longer than that of population v763 (first). The check cultivar has a green leaf duration of about one day longer than the selection population v762 (last).

The distribution of the populations is shown in Figure 1. The differences between the two selection populations and the check cultivar are consistent throughout the time of the experiment.

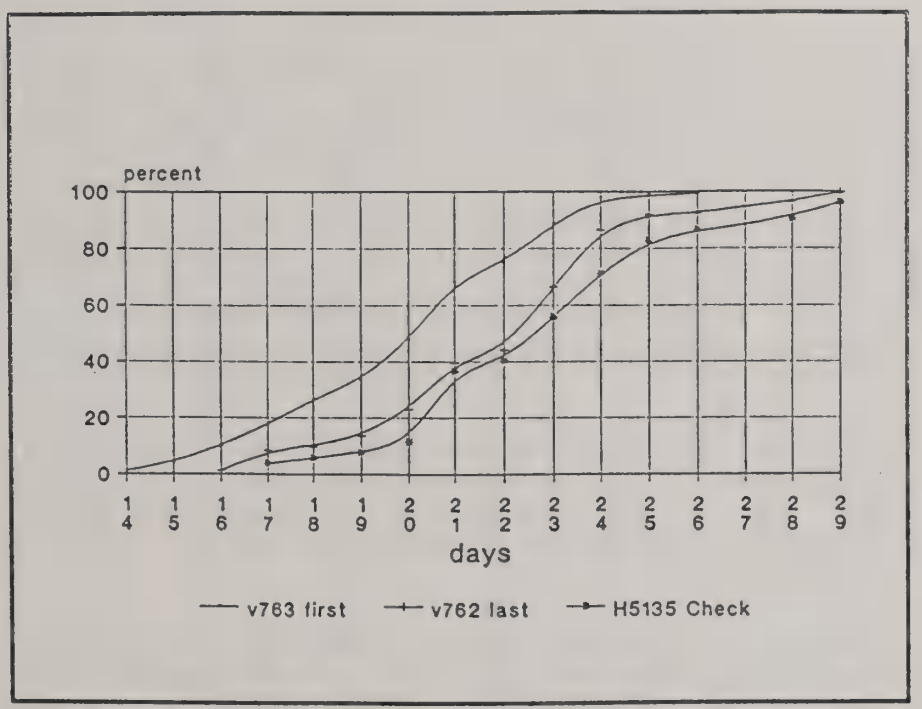

Figure 1. Green leaf duration; first true leaf age at senescence.

These results indicate that green leaf duration is genetically controlled and can be changed by appropriate selection procedures. An additional cycle of selection will be conducted in this population. These populations will be tested in replicated field trials to evaluate the effects of these green leaf duration changes on horticultural characteristics.

Osmotic Concentration.--The high sugar cultivar L19 has been shown to have a higher osmotic pressure than all other sugarbeet germplasm. Last year we measured the leaf osmotic pressure of *B. maritima* accessions from the British Isles and found a significant number had leaf osmotic pressure similar to the L19 germplasm (SUGARBEET RESEARCH 1988 Report, pages D21-D29).

This year a more comprehensive study of the British Isles collection was conducted on root tissue. Ten plants of each of 125 accessions from the British Isles were analyzed for osmotic pressure, soluble solids and sucrose percentage. Analysis was conducted on frozen root tissue of two-month-old plants.

Generally, the root osmotic pressure, root soluble solids and sucrose concentration of two-month-old *B. maritima* plants were not different from the sugarbeet check. Deviations from the sugarbeet check (higher and lower) were about the same as would be expected based on a 5% probability level. These data suggest that the wild *B. maritima* accessions from the British Isles have root osmotic pressures similar to that of sugarbeet, but that their leaf osmotic pressures are higher and are more similar to the high sugar cultivar L19. These higher osmotic pressures in the leaves of *B. maritima* are probably the result of natural selection for survival in high salt concentration environments. We observed many surviving populations at or near high tide, where a constant spray of salt water covered the foliage.

Germplasm Collection.--A successful collection expedition for wild relatives (*Beta maritima*) of sugarbeet was conducted along the Gulf of Lion (Ligurian Sea), along the entire Atlantic coast of France, the Channel Islands (Jersey and Guernsey), the major islands of Denmark and along the Atlantic coast of Belgium. A total of 2,992 individual plants in 123 populations in France, 305 individual plants in 19 populations in Denmark and 57 individual plants in three populations in Belgium were collected. A number of characters of value to the sugarbeet were observed; i.e., monogerm, male sterility and disease resistance. The entire collection will be entered in the Germplasm Resources Information Network (GRIN) and given permanent plant introduction numbers.

A cooperative exchange with the Greek gene bank in Thessaloniki, Greece has resulted in the addition of 32 *B. maritima* collections from the Greek Islands to our gene bank. These will be increased at the Logan, Utah facilities and deposited in the Ames collection for future evaluation and user needs.

Germplasm Multiplication.--100 accessions of the NC-7 collection needing regeneration were multiplied under controlled isolation conditions in Logan, Utah. The collection made this past year will be deposited in the NC-7 *Beta* collection at Ames, Iowa. A portion of each bulk collection will be increased under controlled isolation conditions for evaluation and user needs.

An agreement has been reached with the Turkey gene bank at Izmir, Turkey to increase accessions of the *B. corollinae* section. This cooperative activity will begin in 1990.

Germplasm Evaluation.--Each year approximately 60 accessions from the NC-7 collection at Ames, Iowa are evaluated for priority descriptors by scientists throughout the U.S. This report covers the agronomic tests conducted by Doney (USDA-ARS) and Kern (American Crystal Sugar Co.). Tests were conducted at the American Crystal Research Center in Moorhead, MN. A total of 60 accessions were evaluated in two separate tests. Nine of the accessions bolted and had to be removed prior to harvest. Each test was replicated four times in single row plots. Harvest was by hand. Pictures (cross section) were taken of each accession. Data (harvest and tare lab) are presented as a percent of the mean of the three check cultivars (Ultramono, SP7622-0, L19) (Tables 3 and 4). The entries consisted of fodder, garden and sugar types. Most were high in root yield and low in sucrose percentage. Some (Table 4, however, gave sucrose percentages and recoverable sugar per ton yields equal to the check cultivars. There were significant differences in root shape and ease of harvesting. These differences can be identified by the range in tare percentages (Tables 3 and 4).

Table 3. Evaluation data for 25 accessions and 3 check cultivars in replicated field trials (Moorhead, MN). Data are presented as percent of the mean of the 3 checks.

Code	Rec/T Lbs	Rec/A Lbs	Loss to Molasses	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Tare %
Check Means	226	4352	2.2	13.5	19.2	944	2583	671	5.0
Ultramono	112	127	93	109	115	87	99	91	97
SP7622-0	86	87	107	89	102	108	102	111	98
L19	102	86	100	102	84	105	98	98	105
PI105335	45	34	118	56	78	98	122	124	78
PI117117	63	65	121	73	105	115	117	129	120
PI120689	48	76	131	61	160	117	130	139	60
PI120706	57	52	124	67	91	113	129	124	101
PI140350	51	80	121	62	158	111	129	119	58
PI140358	53	78	125	65	148	111	123	95	63
PI140361	44	64	126	58	143	112	125	83	53
PI141919	42	39	117	55	90	94	134	113	79
PI142814	60	84	113	68	141	119	114	110	49
PI142815	63	86	119	72	137	111	119	123	95
PI142817	50	51	132	63	107	133	125	138	153
PI142820	53	59	124	64	113	120	121	128	58
PI142823	49	50	125	61	104	127	121	128	87
PI148625	47	55	123	59	120	119	134	113	84
PI164978	65	28	105	71	45	92	104	113	194
PI165062	55	60	122	66	111	128	120	120	72
PI171508	78	78	119	85	101	89	119	135	145
PI171515	60	77	129	71	129	112	121	145	115
PI171516	53	85	119	64	159	119	120	120	67
PI171518	52	73	125	64	141	115	120	133	87
PI171519	63	74	118	72	117	103	118	126	99
PI172729	67	79	115	75	119	111	117	115	102
PI172733	56	42	129	68	77	126	129	130	96
PI173844	32	33	110	45	103	110	122	98	60
PI175594	77	83	119	84	107	105	109	136	82
CV %	13.7	19.5	4.7	9.1	17.9	18.1	7.0	6.2	28.3
LSD 0.05	19	27	7	13	25	ns	10	9	6

Table 4. Evaluation data for 25 accessions and 3 check cultivars in replicated (4 replications) field trials (Moorhead, MN). Data are presented as percent of the mean of the 3 checks.

Code	Rec/T Lbs	Rec/A Lbs	Loss to Molasses	Sugar %	Yield T/A	Na ppm	K ppm	AmN ppm	Tare %
Check Means	203	3815	2.4	12.6	18.8	1285	2364	746	4.3
Ultramono	107	124	96	105	115	96	97	95	75
SP7622-0	83	81	106	87	98	115	102	103	113
L19	110	96	98	108	87	89	101	102	113
PI176423	34	47	116	50	140	176	105	86	173
PI176875	75	40	114	83	53	97	109	130	187
PI178836	64	71	120	75	110	116	121	122	99
PI178837	55	67	119	67	124	118	124	116	149
PI179173	56	67	104	65	119	112	99	102	99
PI179174	101	90	101	101	89	86	108	104	120
PI179180	33	50	102	46	154	129	108	79	62
PI181717	42	42	108	54	103	130	119	85	52
PI204677	44	73	120	58	165	110	137	113	39
PI220165	66	87	111	74	134	114	105	113	87
PI220508	92	79	103	94	86	100	110	99	120
PI224684	51	65	106	61	132	121	108	96	46
PI232892	93	57	106	95	61	100	112	105	117
PI232893	101	89	94	100	88	91	103	87	81
PI232894	101	94	99	100	93	94	114	91	105
A 2661	83	44	99	86	53	107	90	102	84
A 2666	91	76	99	93	83	96	94	106	77
A 3039	79	53	106	84	67	97	106	113	117
A 3040	75	73	102	80	97	106	107	96	156
A 3041	81	57	106	85	71	89	115	108	122
A 3042	73	57	113	80	78	100	120	115	135
A 3044	74	41	104	80	56	100	108	105	220
A 3045	85	75	100	87	89	92	112	93	129
A 3047	68	56	106	75	82	122	107	94	193
A 3049	80	51	100	84	63	90	111	96	157
A 3051	70	66	105	77	94	109	112	98	252
CV %	10.6	17.0	3.7	7.4	16.4	10.1	5.3	5.4	27.3
LSD 0.05	15	24	5	10	28	14	8	7	38

An agreement was made with INRA of France to cooperate in the evaluation of the French collection. After adequate seed multiplication of the accessions, the collection will be evaluated in the U.S. for the priority descriptors (SUGARBEET RESEARCH 1988 Report, page D21). The French will evaluate the collection for male sterility, mitochondria differences, bolting, seed germination inhibitors and resistance to Rhizomania, Cercospora leaf spot and nematodes.

This past year we have cooperated with Hilleshög AB, Landskrona, Sweden to evaluate *B. maritima* germplasm for resistance to virus yellows. Preliminary results suggest that accessions from the North Atlantic with thick leaves are resistant to mild virus yellows. This cooperative effort will be continued next year.

Germplasm Enhancement.-- Several dynamic populations (crosses between sugarbeet and *B. maritima*) are in the development stage. These populations will be selected for near-sugarbeet type characteristics. As these populations approach desirable sugarbeet quality, they will be made available to the user community for the enhancement and broadening of genetic diversity in sugarbeet breeding populations.

Six populations (crosses between sugarbeet and wild beet) in the early stages of development were tested in replicated field trials this past year (Table 5). Most roots still exhibited significant sprangling; however, roots of population v41 were relatively smooth and cone-shaped. A significant increase in frost tolerance over the sugarbeet checks was observed in populations v39 and v43. All the populations were about two percentage points below the check cultivars in sugar concentration; however, two (v38 and v40) were approaching the check cultivars in root yield (Table 5).

Table 5. Root yield, sucrose percentage, gross sugar, and recoverable sugar for populations resulting from crosses between sugarbeet and wild Beta maritima germplasm and check cultivars.

Code	Wild Beet Component	Root Yield T/A	Sucrose %	Gross Sugar Lbs/A	Recoverable Sugar Lbs/A
v38	WB147	19.75(102)	11.30(83)	4457(84)	4348(84)
v39	WB147	13.77(71)	11.63(85)	3193(60)	3113(60)
v40	WB284	17.82(93)	11.54(84)	4106(78)	4003(78)
v41	WB245	13.16(68)	11.51(84)	3021(57)	2942(57)
v42	WB242	8.35(43)	11.74(86)	1953(37)	1903(37)
v43	WB31	16.18(84)	11.39(83)	3682(70)	3578(69)
H5135 check	18.01	13.42	4845	4728	
ACH164	check	21.26	13.77	5854	5717
Ultramono	check	18.57	13.92	5166	5041
LSD 0.05		1.90	0.42	453	441
CV %		14.03	4.09	13.9	13.9

Note = numbers in ( ) indicate percent of check cultivars.

SUGARBEET RESEARCH

1989 Report

Section E

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CONTENTS

PUBLICATIONS

Abstracts of Papers Published or Approved for Publication and Germplasm Releases.

Aicher, L. D., and J. W. Saunders. 1989. Inheritance studies and clonal fingerprinting with isozymes in sugarbeet. Crop Sci. 30: In Press.

This study was conducted within a limited sample of Beta vulgaris germplasm to explore leaf isoenzyme variability for use in clonal fingerprinting in addition to inheritance and linkage relationships. Horizontal starch gel electrophoresis employing either of two buffer systems was utilized, followed by multiple enzyme specific staining for eight enzymes. F_1 and F_2 progeny from pair crosses between several clones were evaluated for inheritance and linkage. Seven loci were studied (Mdh1, Mhd2, Mdh3, Mdh4, Mdh5, Pgm1, and Skdh1). An additional locus (Pgi1) is proposed that had normal F_1 but skewed F_2 ratios which could be explained by linkage to an unmapped self-incompatability locus. Pgm1, Pgi1, and Mdh1 were found to segregate independently from each other and from B and R. Evidence for two further loci, Me1 and Me2, was also obtained. Pollen possessed activity for only four of the 10 proposed loci and was useful in interpreting the complex banding patterns for Mdh and Me. The ability to distinguish clones on the basis of zymotypes for seven enzyme systems was demonstrated. Enough variation was found in isoenzyme mobility to be useful in future sugarbeet genetic research.

Doley, W. P., and J. W. Saunders. 1989. Identification of favorable germplasm and medium combinations for shoot regeneration from leaf disc hormone-autonomous callus. J. Sugar Beet Res. 26(1):A6 (Abstract).

Extensive variation was measured within and between 16 sugarbeet populations for frequencies of callus initiation and shoot regeneration, time to callus initiation and time between callus initiation and shoot regeneration. When tested on MS medium with 1 mg/L benzyladenine (BA), leaf discs from expanding leaves of 59 of 78 plants, representing all 16 populations, initiated callus. Of these, 35 plants from 11 populations regenerated shoots on that callus without transfer. Significant variation among plants within populations should allow identification of individuals capable of shoot regeneration in generally unresponsive but otherwise elite populations. Genotype x medium interaction was evaluated in an effort to increase the range of sugarbeet germplasm capable of shoot regeneration. Increased levels of BA, as well as inclusion of certain concentrations of gibberellic acid or naphthaleneacetic acid, increased the frequency of callus and shoot production in some genotypes. Some genotypes produced buds on callus appearing on hormone-free medium. In some cases, it has also been possible to reduce the time to callus initiation. Clustering germplasm sources into response types is proposed as an aid to efficiently increasing the range of sugarbeet germplasm which can be regenerated from callus. Each response type may require a different medium for optimum regeneration.

Doley, W. P., and J. W. Saunders. 1989. Long term regeneration from hormone-autonomous sugarbeet callus. Agron. Abstr. p. 175 (Abstract).

When hormone-autonomous sugarbeet (Beta vulgaris L.) callus is serially subcultured, shoot regeneration rapidly declines. We investigated the effects of genotype, subculture interval, benzyladenine (BA) concentration and triiodobenzoic acid (TIBA) on long term regeneration from calli up to 18 wk old. All calli were initiated from leaf disks on MS + 1 mg/L BA (B1) and subcultured to various media after 3 wk growth. Subculture interval did not effect subsequent shoot regeneration, but calli subcultured more frequently appeared healthier. When calli were subcultured every 3 wk on B1, genotypes differed significantly in rate of decline in shoot regeneration. Regeneration from calli maintained on B1 could be increased by subculture to MS + 3 mg/L BA. The frequency of calli regenerating shoots and the number of shoots per callus were both significantly enhanced by repeatedly doubling the BA concentration at each subculture or by maintenance on B1 + 1 mg/L TIBA. Calli maintained in a non-regenerating state on hormone-free medium could be induced to regenerate by transfer to media containing BA. Manipulation of shoot regeneration with BA and TIBA appears to be compatible with a model involving auxin/cytokinin ratio.

Doley, W. P., and J. W. Saunders. 1989. Hormone-free medium will support callus production and subsequent shoot production from whole plant leaf explants in some sugarbeet (Beta vulgaris L.) populations. Plant Cell Rep. 8:222-225.

Sugarbeet plants representing 14 of 16 germplasm sources tested (4-5 plants per source) produced callus from leaf disks on a hormone-free Murashige-Skoog based medium. Overall, 49.2% of explants from partially expanded leaves of whole plants formed callus, and the average time to first visible callus was 96.7 days. The time to callus was considerably longer than the 4-6 weeks observed when 1 mg/L 6-benzyladenine has been used in the media. Shoots were produced on the hormone-free medium on callus of only eight individual genotypes representing three of the populations tested. Shoots produced by 'Gartons White Knight' and 'L53' appeared to be of somatic embryoid origin. Rhizogenic calli were also produced by the same three populations which regenerated shoots. Significant differences among populations were found for frequency of callus and root from leaf disks, time to callus, and frequency of shoot regeneration from callus. The results indicate the ease of hormone autonomization in sugarbeet and may be of value in designing regeneration media for a wider range of beet germplasm.

Halloin, J. M. 1989. Interactions between Rhizoctonia solani and temperature influence the localization of phenolic compounds within infected sugarbeet roots. J. Sugar Beet Res. 26 (1):A10 (Abstract).

Most infections of sugarbeet roots by Rhizoctonia solani (AG 2-1) develop during the warmest part of summer. As temperatures moderate, infection sites become surrounded by a brown layer of phenolic materials. In this study the relationships between temperature, infection by R. solani, and the formation of phenolic materials within sugarbeet roots were examined. Infections established rapidly at 30°C, whereas there was little evidence of root infection at 15°C. Inoculated roots were first incubated at 30°C for 2 weeks, then transferred to 15°C. Fungal advance through tissues ceased after transfer to the cooler temperature. Next, roots were incubated first at 15°C for 2 weeks, then were transferred to 30°; there was no evidence of infection. Roots that were incubated first at 30°C for 2 weeks, followed by 3 weeks at 15°C, then returned to 30°C, had few (2 of 8) infections that were able to reestablish within 2 weeks. Inoculated roots incubated at 30°C had deposits of oxidized phenolics (condensed tannins) within necrotic tissues, but there were no histochemical evidence for the presence of reduced phenolics. In contrast, the roots with no successful colonization or the roots in which disease progress had ceased, had heavy deposits of both oxidized and reduced phenolic materials at the boundary between healthy tissue and diseased or inoculated tissue. Phenolic compounds in the reduced state may constitute an antimicrobial barrier to the fungus.

Halloin, J. M., E. J. Potchen and R. A. Miller. 1989. Nuclear magnetic resonance imaging as a tool for anatomical and developmental studies of sugarbeet roots. J. Sugar Beet Res. 26 (1):A10 (Abstract).

Methods used to study structure and developmental changes within roots normally are destructive, thereby precluding study of developmental processes within individual roots. Proton nuclear magnetic resonance (NMR) imaging may offer the potential for nondestructive study of roots. We studied the utility of NMR for imaging internal structure of healthy and Rhizoctonia solani-infected sugarbeet roots. Healthy roots showed extremely high contrast between the vascular and parenchyma layers of rings within roots. Parenchyma layers appear very light, whereas vascular layers are dark. Similar NMR images of table beets are grey with low contrast between tissues. NMR images of sucrose gradients in test tubes reveal obvious signal intensity differences between concentrations. Higher sucrose concentrations gave more intense signals. Overall, relative NMR image intensities agree closely with previous reports on the distribution of sucrose in sugarbeet roots. Images of Rhizoctonia-infected roots have a very dark area at the advancing front of an infection. However, infected tissues behind that front have the high contrast within rings that is typical of healthy tissue. NMR imaging is useful for the nondestructive study of sugarbeet root anatomy, development, and disease development; and may prove valuable for monitoring some chemical changes within sugarbeet roots.

Mann, V., L. McIntosh, C. Theurer and J. Hirschberg. 1989. A new cytoplasmic male sterile genotype in the sugar beet Beta vulgaris L.: a molecular analysis. Theor. Appl. Genet. 78:293-297.

Mitochondrial DNA (mtDNA) from fertile (N) and possibly new cytoplasmic male sterile (CMS) genotypes was studied in the sugar beet, Beta vulgaris L. It was found by restriction endonuclease analysis that BMC-CMS, a cytoplasm that was derived from the wild beet, Beta maritima, contained a unique type of mtDNA which is distinguishable from both the N and S-CMS, the only other CMS genotype that is currently available in B. vulgaris L. The organization of three genes: coxI, coxII, and cob, was analyzed by hybridization with heterologous probes from maize. These genes have a similar structure in N and BMC-CMS that is different from S-CMS. It is concluded that BMC-CMS is a novel CMS genotype in the sugar beet.

Saunders, J. W. 1989. Release of Herbicide Resistant Sugarbeet Germplasm CR1-B.

The clone CR1-B is being released because it is resistant to the sulfonylurea herbicide chlorsulfuron and has demonstrated resistance to the analog chlorimuron ethyl in the field. Both herbicides are known to injure sugarbeets when carried over in the soil from preceding cropping years. CR1-B is at least 100X less sensitive in vitro to chlorsulfuron than REL-1. Initial evidence indicates that CR1-B is heterozygous for chlorsulfuron resistance which is inherited in a dominant fashion.

CR1-B is a diploid self-fertile annual clone with N cytoplasm, derived from clone REL-1 by regenerating a shoot arising from callus developed from a cell cluster surviving in vitro exposure to 2.8 nM chlorsulfuron. The genetic background of CR1-B is 50% 6926-0-3 (a selection from SP 6926-0), 25% Owens Annual CMS Tester, and 25% 58-81 (an East Lansing breeding clone selected for resistance against Aphanomyces cochlioides). CR1-B produces abundant pollen, and is easily maintained by in vitro shoot culture. It is expected that the resistance trait will have to be backcrossed into more favorable genetic backgrounds before it appears in commercial hybrids.

CR1-B is heterozygous at the B, M and R loci. It is homozygous for the common fast alleles of phosphoglucoisomerase, phosphoglucomutase and malate dehydrogenase-1, for the common slow allele of malate dehydrogenase-3 and is heterozygous for the common isocitrate dehydrogenase isozyme pattern.

Saunders, J. W., G. Acquaah, K. A. Renner, D. Penner, and W. P. Doley. 1989. Cell selection for herbicide resistance. J. Sugar Beet Res. 26 (1) :A20-21 (Abstract).

Injury to sugarbeets from herbicide residues left from the preceding cropping year has kindled interest in more herbicide resistant cultivars. Because simply inherited herbicide resistance has been obtained on other crops through tissue culture selection schemes, we pursued this in sugarbeet. Using the annual self-fertile diploid released clone, REL-1, with its superior shoot regeneration and suspension cultures, we produced dispersed suspension cultures from callus induced on leaf discs by MS medium + 1 mg/L benzyladenine (BA). Suspensions were subcultured twice in liquid MS + 1 mg/L BA before plating of unmutagenized cell clusters on 2.8 nM chlorsulfuron on MS + 1 mg/L BA with agar. A single colony arose which quickly sent up a shoot. Additional shoots were extracted and treated as separate isolates. Shoots and callus were resistant to chlorsulfuron concentrations that killed similar tissues of REL-1. Initial tests in greenhouse and field indicated that resistance segregates in the F_1 generation. Unique somaclonal variation was observed in plants of many of the isolates or their S_1 progeny. This included tumorigenesis, variegation, partial and complete sterility, and aberrant plant morphology.

Saunders, J. W., W. P. Doley, J. C. Theurer, and M. H. Yu. 1989. Somaclonal variation in sugarbeet, In Y.P.S. Bajaj, Ed., Biotechnology in Agriculture and Forestry, Vol. 11. Springer Verlag. Berlin, Germany. (Book Chapter).

Somaclonal variation includes forms of permanent genetic change produced during passage of cells through tissue culture. Current procedures in sugarbeets for converting genetic variation at the cell level to the whole plant level are reviewed, as is the range of such variation reported to date at the whole plant level. Procedures for using somaclonal variation to alter biochemical behavior in sugarbeet are discussed, as are considerations for studying effects of mutants and incorporating them into commercial varieties with improved processing behavior or resistance to disease or herbicides.

Saunders, J. W., G. Acquaah, K. A. Renner, D. Penner, and W. P. Doley. 1989. Cell selection for sulfonylurea herbicide resistance in sugarbeet. Agron. Abstr. p. 179 (Abstract).

REL-1, a model sugarbeet clone bred for tissue culture applications and rapid generation time, is an annual self-fertile diploid genotype with superior shoot regeneration and suspension cultures. Dispersed suspension cultures were produced from callus induced on REL-1 leaf discs by MS medium + 1 mg/L benzyladenine (BA). Suspensions were subcultured twice in liquid MS + 1 mg/L BA before plating of unmutagenized cell clusters on 2.8 nM chlorsulfuron on MS + 1 mg/L BA with agar. A single colony arose from which shoots were extracted and treated as separate isolates. Shoots and callus were resistant to chlorsulfuron concentrations that killed similar tissues of REL-1. Resistance has been recovered in F_1 and BC_1 progeny in field, greenhouse and in vitro shoot tests indicating a dominant mode of inheritance. In vitro shoot tolerance to chlorsulfuron is at least a hundred fold greater in the resistant isolates than in REL-1. Resistance is also expressed in leaf disc expansion in vitro with MS + 1 mg/L BA, suggesting an easy nondestructive method to identify nonresistant segregants.

Saunders, J. W., J. C. Theurer, and G. Acquaah. 1989. Progress with isoenzyme investigations. J. Sugar Beet Res. 26 (1):A21 (Abstract).

Isoenzymes are multiple functional forms of enzymes that are easily studied using relatively common laboratory procedures. They are useful in fingerprinting clones, populations, and cultivars, as well as for developing linkage maps that are currently being used in selection schemes for quantitative traits in several crops. We have continued investigations using isoenzymes to learn more about isoenzyme structure and expression as well as to develop a linkage map. Continued screening of breeding populations and chard and table beet cultivars has been conducted to identify sources of genetic variability for isoenzyme mobility. Enzymes studied have been malic enzyme, glutamate-oxaloacetate transaminase, glutamate dehydrogenase, aconitase, diaphorase, shikimate dehydrogenase, isocitrate dehydrogenase, malic dehydrogenase, phosphoglucomutase and phosphoglucoisomerase. Aberrant segregation ratios have been encountered with glutamate dehydrogenase and phosphoglucoisomerase. Isozyme patterns from pollen extracts have been used to assist in determining enzyme structure and the relationship among electrophoretic bands. Zymograms from pollen show fewer bands than from leaves, due to differential gene expression and the absence of heterodimeric proteins of monogenic origin.

Theurer, C. 1989. Progress and performance in development of smooth root sugarbeet varieties. J. Sugar Beet Res. 26 (1):A25 (Abstract).

Smooth root sugarbeets, which would have the advantage of easier harvestability, less soil to transport, less bruising and breaking of roots resulting in lower storage losses, and a potentially greater efficiency in processing, are being developed at East Lansing, Michigan. Progress has been made but low sucrose percentage remains at the greatest impairment. Most smooth root progenies are equal to commercial cultivars in root yield and purity, but not in sugar characteristics. Breeding lines with the best smooth root scores were harvested with only 33 to 50% of the soil harvested with commercial cultivars MHE4 and USH23. However, they were one percentage lower in sucrose with between 20-30 pounds less recoverable sugar per ton. At present, the most promising smooth root progenies have 30-40% soil reduction at harvest, 1 to 3 tons/acre less root yield, and a sucrose percentage almost equal to that of commercial cultivars. The growth characteristics of a smooth root line was compared to those of MHE4 and ACH176 cultivars in a 50-day sand culture greenhouse experiment. Results demonstrate that smooth root types and standard varieties partition assimilate similarly to plant parts. There was a tendency for smooth root types to produce fibrous roots lower on the taproot. Approximately 1% of the smooth roots had growth cracks. The use of smooth root lines as components of hybrids will be discussed.

Theurer, J. C. 1989. Michigan research continues on smooth root sugarbeet. Sugar Producer.

Smooth root sugarbeets, which would have the advantages of easier harvestability, less soil to transport, less bruising and breaking of roots resulting in lower storage losses, and a potentially greater efficiency in processing, are being developed at East Lansing, Michigan. The objective is to have a taproot without the grooves filled with a mass of fibrous roots as found in a normal cultivar. The best selections are significantly superior in smoothness or root compared to commercial cultivars and can be harvested with 30-50 percent less soil adhering to the root. Breeding lines have been equal in root yield and clear juice purity but they are lower in sucrose percentage. In a 1988 field trial, four experimental hybrids with our best smooth-root line as a parent were compared with three commercial hybrids being currently used by Michigan growers. The experimental hybrids gave excellent root yield, but were 1-2 percent lower in sugar percent. Current efforts are directed toward breeding higher sucrose content in the smooth-root selections and the development of monogerm, O-type inbreds which can be utilized as parents in smooth-root hybrid varieties.

Theurer, J. C. and D. L. Doney. 1989. Sugarbeet accumulation in L19 type sugarbeet germplasm. J. Sugar Beet Res. 26:55-64.

Seasonal sucrose accumulation of L19, a high sugar type inbred, was compared to that of yield type inbreds and other high sugar type inbreds and hybrids in field experiments during three years. Inbred L19 consistently demonstrated a unique sucrose accumulation pattern compared with other high sugar lines. It was lower in sucrose percentage early in the growing season, followed by a significantly higher rate of sucrose accumulation than other high sugar lines after about 60-70 days growth. This unique sucrose accumulation pattern appeared to carry over into hybrids. An explanation for the more rapid rate of sucrose storage in L19 type sugarbeet is unknown, but may be partly due to its rapid cell division rate and high dry matter content. The consistent seasonal sucrose accumulation pattern of L19 suggests that efforts to evaluate this inbred and other relatively homogeneous high sugar lines might be promising for gaining a better understanding of basic mechanisms controlling sucrose transport and storage in sugarbeet.

Theurer, C., C. Hiser, L. McIntosh, and J. Hirschberg. 1989. Molecular studies on mitochondrial DNA and RNA of some CMS lines of sugarbeet. J. Sugar Beet Res. 26 (1):A26 (Abstract).

Molecular studies have been made of the mitochondrial DNA (mtDNA) and mRNA transcription of 5 sources of cytoplasmic male sterility (CMS) and a normal cytoplasm (N) to differentiate sources of CMS, and attempt to gain a better understanding of the genetic mechanisms controlling CMS in sugarbeet. Differences in restriction fragment length patterns (RFLP) of mtDNA were observed between normal and all CMS cytoplasms. Gamma irradiated sources Si-2, Si-3, and Si-4 showed similar RFLPs to Owens S type CMS, while a Beta maritima source (BMC) was different. Restriction digests of mtDNA and mRNA transcripts were probed with 4 radioactively labeled maize genes, ATP 6, ATP 9, COX I, and COX II, known to be correlated with CMS in maize and petunia. Differences in mtDNA restriction fragments were noted for CMS vs N when probed with ATP 9 and COX II, suggesting DNA rearrangements in or near these genes in the CMS. Northern blotting experiments indicated that the COX II gene DNA rearrangements were transcribed in Si-4 CMS but the ATP 9 gene rearrangements were not. The altered transcripts were not modified by nuclear pollen restorer genes. Slot blots of nucleic acids from buds, anthers, and pollen probed with ATP 9 and COX II genes suggested a down-regulation of gene transcription from buds to anthers to pollen. Higher levels of the COX II gene were transcribed to CMS buds than in N buds.

INHERITANCE AND PHYSIOLOGY STUDIES OF THE CHLORSULFURON RESISTANCE DERIVED FROM SOMATIC CELL SELECTION

Joseph W. Saunders and Steve Hart

Isolate CR1-B was found to have a 300-1000 fold greater tolerance to chlorsulfuron than source clone REL-1 in in vitro shoot tests over a wide range of concentrations. CR1-B was released to the public as clonal propagules, initially as rooted shoots on agar to retain the option to propagate in vitro. CR1-B in whole plant form was later made available.

Chlorsulfuron resistance was transferred in three successive outcrosses as part of a program to put it in a smooth-rooted breeding background. In all cases it behaved as a single dominant allele, unlinked to the R locus. No gene symbol has been chosen yet, awaiting determination of the mechanism of resistance. A postemergence soil drench application at 2.8μM in a peaty commercial potting mix was used to identify resistant and susceptible (dying) segregates.

A homozygous S_1 individual from isolate CR1-AB was identified by test crosses. S_2 seed will soon be ready for release. Due to two generations of selfing and an apparent load of extraneous somaclonal variation likely to be independent of the herbicide resistance, average plant vigor in this S_2 population is relatively low. The homozygous S_1 plant does not produce copious pollen.

Greenhouse studies were conducted in the winter using S_1 seed of both CR1-B and its source clone REL-1, in order to determine magnitude of resistance and extent of cross resistance to other herbicides that act by inhibiting acetolactate synthase (ALS). Plants were sprayed post-emergence at the 2-4 leaf stage with 1/2, 1 and 2 times the field use rate of ten different ALS inhibiting herbicides: chlorsulfuron, metsulfuron, triasulfuron, DPX-L5300, chlorimuron ethyl, DPX-M6316, CGA-136872, DPX-V9360, imazaquin and imazapyr. CR1-B S_1 plants showed a mean moderate degree of resistance to chlorsulfuron at 1/2 the field use rate, but severe injury at the two higher rates. CR1-B S_1 plants were on the average less resistant to field use rates of metsulfuron, triasulfuron, DPX-L5300, DPX-V9360, imazaquin and imazapyr at 1/2 the field use rate. CR1-B S_1 plants exhibited a mean moderate degree of cross-resistance to chlorimuron ethyl at the half and full field use rates. Highest relative resistance was to full field rates of DPX-M6316 and CGA-136872. S_1 plants of REL-1 were severely injured or killed by all rates of all herbicides. Because S_1 plants of heterozygous CR1-B were used, about a quarter of the herbicide treated plants showed the susceptible reaction at those rates where other plants showed less or no damage. True breeding seed was not available for this study. Furthermore, comparison of herbicides for effect on CR1-B was done only at the "field use rate" for each herbicide, not at the same molar concentration, and thus reflected recommended rates for use in a variety of crops.

Initial results of rate titration experiments with DPX-M6316 and CGA-136872 on CR1-B S_1 plants suggest that severe injury occurs only at or above 8-12 times the field use rate, suggesting potential use of these herbicides in a beet crop containing the resistance. Both herbicides, as well as chlorsulfuron, are in the sulfonylurea chemical family.

ISOENZYME STUDIES

J. W. Saunders, William P. Doley, George Acquaah and J. C. Theurer

Glutamate Dehydrogenase. GDH was reported in last year's report to behave anomalously, with no apparent heterozygote banding pattern seen in F_1 plants of a cross of two clones each having a single band of different mobility. A dimeric enzyme (two subunit types) would have a three-banded heterozygote pattern, and a monomeric enzyme would give a two-banded heterozygote pattern. Clone J-3 was a stigmoid male sterile individual showing the only variation for GDH banding seen in an earlier germplasm screening. By examining F_2 progeny of a cross of J-3 with AP-1, a clone from the Owens Annual maintainer population, it was ascertained that in our system, GDH is only seen as either one of three single bands, with the heterozygote having a single band of intermediate mobility. In theory, the middle band of a three-banded heterozygote pattern contains 50% of the activity, with either flanking band having 25%. With most dimeric enzymes, all three bands are visible, but with GDH, the threshold for visibility appears to be above the 25% mark. With this understood, we found good fit for Gdh to a monogenic model.

Phosphoglucoisomerase. Pgi segregation ratios were earlier found to be distorted in an F_2 family from a heterozygous (SF) F_1, whereas progeny of a two parent SF x SF cross segregated normally. A tentative hypothesis to explain the segregation anomaly invoked linkage of Pgi to the self-fertility factor segregating in the F_2 family but not in the SF x SF cross. However, it was impossible to test that hypothesis in the F_2 population due to segregation of male sterility maintenance in a sterile cytoplasm.

Pgi segregated in F_2 plants of the aforementioned J-3 x AP-1 cross. Once again, the ratio was distorted consistent with linkage of Pgi to the self-fertility factor contributed by AP-1. In this population also, testing of that model was precluded by non-availability of a random sample of F_2 plants for self-fertility scoring, as both stigmoid antherless as well as the traditional pollenless plants segregated out. Our next attempt to explain the anomalous segregation of Pgi in some families will involve an F_2 population in which all plants can be evaluated for self-fertility.

Linkage. Tissue culture clone REL-1 is heterozygous for R, B and isocitrate dehydrogenase (IDH) banding pattern. Based on segregation ratios of a hundred S_1 plants of REL-1, B was found linked to Idh with a recombination frequency of 0.01 + 0.01%. Smed et al. (1989) reported Idh and R linkage with a recombination frequency of approximately 0.17, and we independently noted R-Idh linkage early in 1989. Thus, Idh segregation could be used to identify segregating annuals and biennials at the seedling stage if the efficiency gained was worth the expense of performing the electrophoresis. In our program at East Lansing, the monogenic annual is heavily used to accelerate generation times.

Glutamate dehydrogenase (Gdh) was found unlinked to malate dehydrogenase-1 (Mdh-1) and to R in F_2 progeny of the J-3 x AP-1 cross. In F_2 families

from another cross, shikimate dehydrogenase (Skdh) was found unlinked to R and to Pgm (phosphoglucomutase).

Beta lomatogona. Six accessions of this wild relative of sugarbeet were zymotyped as part of a long term effort to study apomixis in the species and transfer it to sugarbeet. Number of plants available per accession ranged from two to thirteen. Variation was seen among some accessions for shikimate dehydrogenase (SKDH), malate dehydrogenase (MDH) 1 and 3, phosphoglucoisomerase (PGI), isocitrate dehydrogenase (IDH), phosphoglucomutase (PGM) and malic enzyme (ME). Variability was common for several enzymes within one accession (WB 222), which also happened to have the largest sample number. This data is encouraging because it indicates isoenzyme fingerprints can be used as markers to distinguish apomictic from sexual progeny in B. lomatogona and derivatives, as well as because enough mobility differences were seen between B. lomatogona and B. vulgaris to be useful in marking interspecific hybrids.

USE OF SOLARIZATION FOR ENHANCEMENT OF SUGARBEET YIELDS

John M. Halloin

Solarization, covering of soil with clear plastic to entrap infrared radiation, has been used successfully to reduce soil-borne diseases and enhance yields of cotton in California and Israel. These locations normally have high levels of solar radiation. Experiments are in progress to determine if the method is useful with sugarbeets in Michigan, a location that normally received considerably less solar radiation than California.

Test plots in East Lansing, MI were covered with clear plastic for two months during the summer of 1988. Control plots were covered with black plastic, cropped with corn, or maintained as barren fallow. Four weeks after covering, soil temperatures were 17% warmer at the surface and 5 ^{o}C warmer at the depth of 20 cm than the average of temperatures in control plots. Plots were planted with sugarbeets in late April (early planting) or early June (late planting) of 1989. There was no visual evidence of seedling, root or foliage diseases in any of the plots. Solarization the year prior to planting resulted in greater than 20 percent increases in both root yields and extractable sugar yields over those obtained from control plots. Additional years and locations are being tested to determine the repeatability of these findings.

GENOTYPE X NITROGEN RESPONSE

J. C. Theurer and J. W. Saunders

Nitrogen is an important element for stimulating early seedling growth and rapid development of the sugarbeet canopy. However, an excess of nitrogen near the end of the growing season results in lower sucrose percentage in the taproot, and higher levels of impurities that interfere with sugar crystalization in the processing factory. Numerous experiments have been conducted to assay the affects of varying rates of nitrogen applied to the commercial crop. Using soil, petiole or early root harvest tests, scientists have established recommendations for optimum nitrogen application for sugarbeet growing areas. For Michigan, Dr. Donald Christenson and others in the Crop and Soils Sciences Department at Michigan State University, have determined that the optimum rate is about 90-100 lbs available nitrogen per acre.

Little is known about the basic genetic and biochemical causes for the nitrogen/sucrose inverse interaction. Most nitrogen rate studies have involved one or two commercial cultivars, and little work has been done to study the interaction of genotype x nitrogen. In one study James et al., (1978) observed that there was a definite interaction between sugarbeet varieties and nitrogen soil fertility for all of the important components of sugarbeet yield and quality. These results demonstrated interactions at the low end and at the high end of the N availability scale. (The experiment involved 0, 84, 210, and 525 kg/ha ammonium nitrate). Interactions at the low fertility level implies that cultivars could be developed that produce high sugar yield at low N levels. At high N levels, yield is generally increased and sucrose percent is decreased. In their study, the observed interactions at the high N scale suggest that sufficient genetic variation may exist to develop varieties that can more efficiently use high levels of N to increase root yield, without a decrease in sucrose percent. Milford and Watson (1971) and Doney et al., (1981) reported that higher levels of N increased root size by increasing cell volume rather than cell number. They suggested that as a result of the cell volume to sucrose concentration relationship (i.e., low cell volume = high sucrose and high cell volume = low sucrose concentration) that excessive N stimulated cell enlargement, resulting in less sucrose and more water in the cell.

Nitrogen is taken up by the beet crop primarily in the form of nitrate. Nitrate passes through the root unaltered, and is reduced in photosynthetic tissues, ending up as glutamine (Burba, 1983). Roots rely for their organic nitrogen on the downshipment of organic foliar nitrogen, primarily glutamine. From a processing point of view, glutamine/glutamate is a major component of clear juice impurity. It is also the key hub of active organic nitrogen distribution in the cell. Glutamine/glutamate concentration in the roots is probably regulated by multiple mechanisms.

Mutations of either regulation or enzyme function for the steps of nitrogen uptake, transport, reduction and interconversion could be of interest to the beet industry if these mutations were associated with (a) greater fertilizer use efficiency, (b) greater sugar percentage and juice purity (in the case of poorer efficiency), or (c) simply lower nitrogenous clear juice impurity

levels (if glutamine/glutamate pool levels in the root are lower).

There are few plant mutations known to affect nitrogen assimilation without drastic effects on plant vigor. One example involves the two gene system differentiating burley and flue-cured tobacco that confers a four-fold difference in nitrogen use efficiency, and is localized in the shoot (Crafts-Brandner et al., 1987). This genetic variation occurred naturally.

Research was initiated this year to investigate further the genotype x nitrogen-sucrose concentration relationship, with an ultimate goal to identify some of the basic genetic factors governing these interactions. We are embarking on efforts to isolate and characterize genetic variation in the nitrogen assimilation machinery, preferable of a monogenic dominant nature. Part of this will involve laboratory attempts to isolate somaclonal variants after imposition of selective regimes. From the present perspective, the easiest mutants to obtain would involve altered nitrate reductase activity or glutamine synthetase inhibitor sensitivity. Neither would probably by itself have commercial value. Increased nitrogen use efficiency or lower free glutamine/glutamate levels are more difficult to select for in vitro, and obtaining such mutants may require discovery or development of novel selective regimes, if not the receipt of good fortune.

Two field experiments were conducted in 1989 to begin this area of research. One (Experiment 8913) was at the Bean and Beet Farm at Saginaw on Charity clay soil and the other was at the soils farm at East Lansing on sandy loam soil. Data from both experiments are given in this report.

Experiment 8913. Pilot test of breeding lines for genotype x nitrogen response.

Nine breeding lines selected for wide diversity in sucrose percentage, and root yield were studied in an effort to detect genotype x fertilizer interactions. MHE4 was included in the test as a check. Each variety was seeded April 19, 1989, in a randomized block experiment of four replications in a two-row plot 28" (70 cm) apart x 30' (9 m) in length. Prior to seeding the field was fertilized with the recommended standard of 100 pounds available nitrogen per acre. In mid-July each replicate was split down the center and an additional 100 pounds of available N per acre was applied to a half of each replicate creating a split plot experiment. All beets in sub-plots of 2 rows x 12' (3.6 m) were harvested by hand on September 21 and 22. The harvest date was earlier than desired but was necessary in order to open the field for machine harvest of other experiments.

RESULTS

Means for nitrogen level, varieties, and nitrogen level x varieties for the variables studied are listed in Table 1. Summed across varieties the N_1 treatment showed approximately the same yield of root as N_2, significantly higher sugar percent, CJP%, and root/top ratio, and significantly lower amino N at harvest. High yield varieties (84B9-71, 85B2R14, and 85300-117) and the SR87 smooth root were not significantly different than MHE4 for RWSA and tonnage/acre. The high sugar line 88S2-00 was significantly better than all other entries for RWST. Three other high sugar lines (L19, 28M3, and

88S1-00) and two high yield lines (84B9-71 and 85300-LH7) were equal to MHE4 in RWST. Three high sugar lines (K19, 88S1-00 and 88S2-00) had significantly higher sucrose percentage than MHE4 when data was summarized over nitrogen levels.

An unexpected noteworthy observation was that the high sugar lines L19 and 28M3 accumulated significantly more amino N in the roots than did any other line. With the exception of the 28M3 variety, differences in RWSA, tons/acre, CJP%, root/top ratio, and amino N between the two nitrogen levels were negligible. Entry 28M3 showed significantly higher root and sugar yield, sucrose percentage, and RWST with N_1 nitrogen level and significantly more amino N accumulation under the N_2 treatment.

Line 85300-117 showed a marked increase with additional N compared to all other varieties except MHE4, with minimal drop in purity. SR87 showed significantly more amino N with the N_2 than the N_1 treatment. Four varieties in addition to 28M3 were greatly affected by an increase in nitrogen during the growing season. High sugar line (88S2-00), high yield lines (84B9-71 and 85B2R14) and SR87 produced significantly higher sucrose percent and RWST with the N_1 versus the N_2 treatment.

The dark green color of all plots at harvest, not only in this field test but also in others on the same land, and the generally low sucrose percentage in all varieties, suggested that there was high residual nitrogen in the soil, perhaps in part from the very dry summer of 1988. Also the stand of K19 was not good due to poor seed germination. Although adjustments were made for wide gaps between beets within the row, the data for this variety may not be as representative of the real performance potential as it could have been with a good stand.

Experiment 8940 - Comparison of Half-sib and experimental hybrids for genotype x nitrogen level x sucrose interactions.

There were eight entries in this split plot randomized block experiment with three replications. The first 3 lines were half-sib progenies of East Lansing near O-type monogerm clones, Entry 4 was L19, a high sucrose open pollinated line. Entries 5, 6, 7, and 8 were experimental hybrids of 576 CMS, EL 36 CMS, 657 CMS, and FC 607 CMS respectively, crossed with a common pair-cross pollen parent. Individual plots consisted of four 28" (71 cm) rows by 25' (7.6 m) row length. Three nitrogen levels were used: N_o = no nitrogen added; N_1 = 100 lbs. available N broadcast preplant, and N_2 100 lbs. available N preplant plus an additional 100 lbs. N broadcast on July 21, 1989.

The experiment was planted on May 31, 1989 and thinned and weeded on July 10, 1989. Due to the poor germination of L19 (entry 4) which resulted in a poor stand in the field, this variety was replanted June 8, 1989. Harvest was made October 26, 1989 using an experimental mini-harvester with puller wheels and a series of rotating star rinks similar to those for a conventional sugarbeet harvester. Beets were

bagged and transported to the laboratory at the B & B Research Farm where they were weighed and sampled for sucrose content and purity.

A 10-beet sample from each field plot was sawed with a 10-blade Spreckles saw to obtain brei for lab analysis. Sucrose percentage, clear juice purity, and meq amino N was determined on the pressed juice from each brei sample, at the Michigan Sugar Company Research Lab at Carrollton, MI, using standard analysis techniques.

RESULTS

An excellent stand was obtained in all plots at the time of thinning. The N_o treatment showed typical leaf yellowing indicating nitrogen deficiency, and this treatment also exhibited less vigor during the growing season. In late August and September beets with the N_2 treatment showed dark green leaves with larger canopies than beets in the N_1. We had planned to determine the nitrogen level in the field prior to planting. Soil samples were taken but due to communication error we did not get a reading for N with our soil analysis.

Mean recoverable sugar per acre (RWSA), recoverable sugar per ton (RWST), tons/acre, sucrose percent, clear juice purity percent (CJP) and meq amino N in taproot samples are listed in Table 2.

Significant differences were noted for varieties and nitrogen levels, but there were few variety x nitrogen interactions. The N_o treatment gave significantly lower RWSA and tons/acre than N_1 or N_2. The high nitrogen treatment (N_2) resulted in significantly lower sucrose percent and RWST than the zero and 100 lbs nitrogen levels. Effects due to nitrogen treatments were significantly different at each level for CJP percent and meq amino N. Purity of the N_o treatment exceeded that of N_1, and N_1 exceeded that of N_2. The meq amino N results were just opposite of the CJP%, in that N_2 had the highest and N_o the lowest amino N in the root. L19 had a higher sugar content and RWST than all other varieties at each N level. Again, as in Experiment 8913, L19 had extremely high amino N content and low purity at harvest. This was not expected from a high sugar line, and the cause of such result is puzzling. More research needs to be done to explain this observation.

The four experimental hybrids in the test showed different root yield response with increased N levels. Hybrids 6 and 7 had high yield increases while 5 and 8 showed the least increase in root weight when N was increased from the standard 100 lbs/acre (N_1) rate to the 200 lbs/acre rate (N_2).

Hybrids 5 and 7 were the entries with the lowest meq of amino N. Hybrid 7 had the lowest sucrose at the N_o level and excluding L19, had the highest sucrose at the N_1 level. This difference approached significance at the 5% level.

It may be that the varieties used in this study do not have sufficient variability to demonstrate wide N x genotype interactions. Alternatively, more than three levels of N might have been needed to recognize differences.

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Table 1. Means by variety, nitrogen level, and variety x nitrogen level for sugar yield, root yield, RWST, sucrose percent, clear juice purity percent, and meq/l amino nitrogen. 1989 Experiment 8913.

List Of Variables

Var	Type		Name / Description
1	TEXT	9	VARIETY
2	TEXT	8	NITROGEN LEVEL
3	NUMERIC		RWSA
4	NUMERIC		RWST
5	NUMERIC		TONS/ACRE
6	NUMERIC		SUCROSE %
7	NUMERIC		CJP %
8	NUMERIC		R/T RATIO FRESH WEIGHT
9	NUMERIC		AMINO NITROGEN 10(meq/l)

1	2	3	4	5	6	7	8	9
MHE4		5523.0	218.0	25.3	13.60	92.30	1.25	215.0
K19		3974.0	224.0	17.7	14.70	89.80	1.85	434.0
28M3		4161.0	218.0	18.9	14.10	90.50	1.52	386.0
88S1-00		4682.0	226.0	20.5	14.30	91.60	1.38	249.0
88S2-00		4376.0	239.0	18.3	14.90	92.00	1.30	279.0
84B9-71		5298.0	210.0	25.0	13.10	92.20	1.10	201.0
83B15-00		4351.0	204.0	21.2	12.90	91.90	0.90	264.0
SR87		5231.0	196.0	26.6	12.40	91.70	1.65	236.0
85300-117		5175.0	217.0	23.9	13.40	92.60	1.15	207.0
85B2R14		4910.0	199.0	24.5	12.60	92.00	1.10	213.0
LSD .05		587.9	11.4	2.7	0.54	0.88	0.34	46.0
	100LBS/A	4974.0	224.4	22.3	14.04	92.14	1.41	242.0
	200LBS/A	4563.0	206.7	22.2	13.22	91.26	1.24	295.0
MHE4	100LBS/A	5367.0	226.2	23.7	13.95	92.82	1.31	187.0
MHE4	200LBS/A	5680.0	210.0	27.0	13.27	91.81	1.20	244.0
K19	100LBS/A	3987.0	230.7	17.3	15.01	90.14	1.67	414.0
K19	200LBS/A	3963.0	217.9	18.2	14.42	89.51	2.04	454.0
28M3	100LBS/A	4938.0	228.7	21.5	14.49	91.40	1.80	351.0
28M3	200LBS/A	3386.0	207.8	16.3	13.71	89.75	1.25	423.0
88S1-00	100LBS/A	4773.0	233.7	20.3	14.59	92.10	1.56	226.0
88S1-00	200LBS/A	4592.0	219.9	20.8	14.03	91.14	1.21	273.0
88S2-00	100LBS/A	4661.0	252.0	18.5	15.54	92.53	1.33	265.0
88S2-00	200LBS/A	4093.0	226.9	18.2	14.33	91.55	1.27	294.0
84B9-71	100LBS/A	5692.0	220.6	25.8	13.63	92.82	1.21	172.0
84B9-71	200LBS/A	4905.0	201.2	24.3	12.75	91.76	1.00	231.0
83B15-00	100LBS/A	4592.0	210.6	21.9	13.17	92.32	1.05	239.0
83B15-00	200LBS/A	4110.0	199.1	20.6	12.69	91.52	0.75	291.0
SR87	100LBS/A	5608.0	209.2	26.8	13.13	92.15	1.84	195.0
SR87	200LBS/A	4856.0	182.8	26.6	11.76	91.29	1.47	277.0
85300-117	100LBS/A	5004.0	224.0	22.3	13.81	92.89	1.11	195.0
85300-117	200LBS/A	5346.0	210.3	25.5	13.12	92.48	1.21	221.0
85B2R14	100LBS/A	5118.0	208.8	24.5	13.09	92.23	1.25	182.0
85B2R14	200LBS/A	4704.0	190.8	24.7	12.12	91.82	0.96	245.0
MEAN		4768.7	215.6	22.2	13.60	91.70	1.33	268.8
LSD .05		831.4	16.2	3.8	0.76	1.24	0.47	65.1
CV		12.3	5.3	12.1	3.93	0.95	25.2	17.1

Table 2. Means of variety x nitrogen level for RWSA, Tons/Acre, RWST, Sucrose percent, Clear Juice Purity, and meq amino N - 1989 Experiment 8940. Soils Farm, East Lansing

VARIETY Code No.	N_o		NITROGEN LEVEL N_1		N_2	
			RWSA			
1	3389	LJK	4165	CDEFGH	4131	DEFGH
2	3687	FGHIJK	4554	BCDE	4529	BCDE
3	3477	HIJK	4247	CDEFG	4343	BCDEFG
4	3015	K	3303	JK	3642	GHIJK
5	3818	EFGHIJ	4525	BCDE	4460	BCDE
6	4395	BCDEF	5526	A	5514	A
7	4085	DEFGHI	4910	ABC	5035	AB
8	3926	EFGHIJ	4771	BCD	4477	BCDE
Mean	3724	B	4550	A	4516	A
C.V.	9.00					
			TONS/ACRE			
1	14.39	H	17.10	DEFG	18.16	DE
2	15.42	FGH	18.66	D	19.58	CD
3	14.47	H	17.84	DEF	18.89	D
4	11.09	J	11.83	IJ	13.77	HI
5	15.14	GH	18.13	DE	18.71	D
6	18.22	DE	22.99	AB	24.38	A
7	17.10	DEFG	19.59	CD	21.64	BC
8	16.01	EFGH	19.47	CD	19.90	D
Mean	15.23	B	18.20	A	19.26	A
C.V.	7.64					
			RWST			
1	235.3	CDEF	242.9	CDEF	227.5	F
2	238.8	CDEF	243.8	CDEF	231.3	DEF
3	240.1	CDEF	238.5	CDEF	229.9	EF
4	272.1	A	279.4	A	264.4	AB
5	251.9	BC	249.3	BCDE	237.9	CDEF
6	241.0	CDEF	240.6	CDEF	226.2	F
7	239.3	CDEF	250.8	BCD	232.1	DEF
8	244.9	CDEF	245.2	CDEF	236.7	CDEF
Mean	245.4	A	248.8	A	235.8	B
C.V	4.07					

Table 2. (continued) Means of variety x Nitrogen level for RWSA, Tons/Acre, RWST, Sucrose percent, Clear Juice Purity, and meq amino N - 1989 Experiment 8940. Soils Farm, East Lansing

SUCROSE %

1	14.48	BC	15.12	BC	14.45	BC
2	14.68	BC	15.00	BC	14.60	BC
3	14.57	BC	14.66	BC	14.40	BC
4	16.86	A	17.45	A	16.65	A
5	15.07	BC	15.09	BC	14.59	BC
6	14.53	BC	14.66	BC	14.11	C
7	14.48	BC	15.23	B	14.54	BC
8	14.88	BC	14.98	BC	14.68	BC
Mean	14.95	AB	15.27	A	14.75	B
C.V.	3.60					

CJP%

1	92.84	DEFG	92.17	GHIJ	91.36	K
2	92.86	DEFG	92.77	DEFGH	91.61	JK
3	93.53	ABCD	92.86	DEFG	92.02	HIJK
4	92.16	GHIJ	91.70	IJK	91.45	JK
5	94.15	A	93.56	ABCD	92.98	CDEF
6	93.85	AB	93.31	BCD	92.23	FGHIJ
7	93.68	ABC	93.37	ABCD	91.95	IJK
8	93.40	ABCD	93.13	BCDE	92.45	EFGHI
Mean	93.31	A	92.86	B	92.00	C
C.V.	0.45					

AMINO NITROGEN 10 (meq/L)

1	198.0	EFGHIJ	265.0	DE	332.3	BC
2	194.0	FGHIJ	202.7	EFGHI	289.7	BCD
3	174.0	HIJ	170.0	HIJ	261.3	DEF
4	342.0	B	413.7	A	410.7	A
5	164.3	HIJ	192.0	GHIJ	227.7	DEFGH
6	172.0	HIJ	195.0	FGHIJ	271.3	CD
7	131.7	J	179.3	GHIJ	229.3	DEFGH
8	154.7	IJ	199.7	EFGHIJ	244.7	DEFG
Mean	191.3	C	227.6	B	283.4	A
C.V.	15.11					

*Means with same letters within N level groups are not significantly different (Duncan's multiple range test 0.05 level).

MODIFICATIONS OF ROOT DYNAMICS OF TWO SUGARBEET VARIETIES GROWN ON A CONOVER LOAM SOIL

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Rhizobotany, the study of plant root growth and development within the surrounding rhizosphere is an area of needed research that is receiving increasing scientific interest. Generalized findings have been made in earlier years, based upon the difficult task of excavating undamaged root systems. In recent years the development of minirhizotron and computer technology has made it easier to more accurately study the temporal and spatial development of fibrous roots in situ in the field (Smucker et al. 1988, Upchurch and Ritchie 1984).

The fibrous root system becomes an important factor regarding sugar production. Sufficient fibrous roots need to be produced to efficiently transport water and minerals from the soil into the sugarbeet taproot, and at the same time not become a sink for photosynthate that could be partitioned to sucrose storage. Silvius and Snyder (1979) reported that some genotypes retain relatively more photosynthate in the taproot at the expense of the fibrous roots, and that invertase may be involved in deflection of sucrose into fibrous root growth.

The smooth root type beets we are developing tend to have fibrous root growth that is different from standard commercial varieties. This year we used the minirhizotron technique to compare fibrous root turnover in SR87, a smooth line, with the commercial hybrid MHE4, under three planting densities.

Results of this study are given in this report.

METHODS

The two cultivars of sugarbeets were planted in a conventionally tilled Conover loam soil, located at the Crops and Soils Research Farm on the campus of Michigan State University on June 8, 1989. Row spacings were 10 (25), 16 (41), and 22 inches (56 cm). Fertilizer and herbicides were applied at the same linear rates for all row spacings according to the recommendations of the Cooperative Extension Service for 28 in. rows. Three clear polybuterate plastic tubes (minirhizotron) were installed between plants in the rows at 2 m spacings, beginning 2 m from each end of the plots, the second and third days after planting. Plants emerged uniformly and were thinned to 20 cm plant spacings for each of the three row spacings when the plants were at the 3 and 4 leaf stages. Plants were sampled for tap root to leaf weight ratio (TLWR) measurements on August 2, 1989 (55 DAP). Weeds were controlled by hoeing. Nondestructive root observations were made, to depths of 1.5 meters, by the minirhizotron (Smucker et al., 1988) and microvideo color camera method (Upchurch and Ritchie 1984) at 34, 49, 69, 84, and 105 DAP. Plants were harvested on October 18 (132 DAP). Analyses for sugarbeet quality were determined by the Michigan Sugar Company Laboratory.

RESULTS

Root numbers in the upper 40 cm were inversely related to row spacing. There was an average of 12% more roots in the soil profile to a depth of 100 cm in the 25 cm row spacing. There were 29% more roots in sugarbeets planted at 25 cm, 34 DAP. These differences diminished to 7% greater at 105 DAP. For the 15-day period from 34 to 49 DAP, the greatest root growth was observed for the SR-87 cultivar planted at the 16 in. row spacing, Fig. 1.

More than 700 new roots were appearing each day at the 30 cm depth. Nearly 550 new roots appeared at 40 cm depth, during this period of time for the cultivar MHE-4 planted at 53 cm row spacing. Maximum depth of root growth was 100 cm and no roots appeared to die during this early period of plant growth. Some root death occurred at the 10, 20, 40, and 80 cm depths during the period from 49 - 69 DAP. Root growth in the 0 - 80 soil depths was somewhat uniform for both cultivars and all row spacings, with up to 400 roots developing each day for the cultivar MHE-4 during the period from 49 to 69 DAP, Fig. 1. There were significantly greater death rates among the roots of cultivar SR-87 at all depths, except at 30 and 60 cm, 69 to 84 DAP when averaged over spacing. Root growth for cultivar MHE-4 continued during this period of time, Fig. 1. Most of the fibrous roots were dying during the period from 84 - 105 DAP. As many as 325 roots died per meter squared each day. Since there were more roots in the 25 cm row spacings, more roots died in these treatments, Fig. 1.

There were consistently more fibrous roots, an average of nearly 15% more after 49 DAP, observed for the sugarbeet cultivar MHE-4, Table 1. No differences in root number were observed at 34 DAP. Fibrous root numbers on the smooth root cultivar, SR-87 were consistently lower during the stages of increased root growth as well as at stages when roots were dying, i.e., 84 DAP and later.

Tap root to leaf weight ratio (TLWR) values, 55 DAP, were similar for both cultivars across all row spacings, Table 2. However, there were significantly larger TLWR values with increasing spacings between the rows. Root to shoot ratios were also greater at 55 DAP. These ratios were much greater at harvest, 132 DAP, but not significantly different among the row spacings. The number of fibrous roots remaining on the tap root were similar between the two varieties, 55 DAP, Table 2. However, there was a 52% decline in the number of fibrous roots per gram of tap root as the row spacings increased. The very low values of this ratio at harvest resulted from the increase in weight of the tap root as well as the decline in the number of fibrous roots after 69 DAP, Fig. 1, Tables 1 and 2.

Root yield of the smooth root cultivar was 47, 36, and 28% greater for the 10, 16, and 22 in. row spacings, respectively, Table 3. However, the percent of sucrose in this variety was lower than the commercial variety MHE-4. The recoverable white sugar production per acre (RWSA) values were 22, 19, and 6% greater for the cultivar SR-87 planted at 10, 16, and 22 in., respectively. Sugar quality, as indicated by the clear juice purity, was generally better for the MHE-4 cultivar, at all row spacings.

In conclusion, narrower rows reduced root yields and increased sucrose content resulting in somewhat greater, although not significantly greater, production of recoverable white sugar for the smooth sugarbeet cultivar, SR-87. The cultivar MHE-4 appeared to be less sensitive than SR87 to the spacing of rows. Narrower rows definitely increased the number of roots in the top 100 cm of the soil profile. Whether this resulted in greater absorption of water and nutrients remains to be determined in future experiments. The higher specific root number, 1.9 fibrous roots per gram of tap root of cultivar MHE-4 at harvest may have had an effect of lowering the yield of this cultivar.

Table 1. Root counts in 0-100 cm of soil by minirhizotron tubes, for two sugarbeet varieties planted at three row spacings (n=12).

Treatment	Root numbers in 259 cm^2 soil profile				
Varieties	34 DAP*	49 DAP	69 DAP	84 DAP	105 DAP
MHE-4	1770	4028	6219	5189	4880
SR-87	1730	3481	5466	4276	4157
Row Spacing					
10 in	1334	2721	4106	3434	2964
16 in	1214	2499	3845	2985	2876
22 in	952	2289	3743	3045	3188

*Days after planting root depth from 0-80 (207 cm^2)

Table 2. Fibrous root responses of two sugarbeet varieties to three row spacings (n=12).

Varieties	TLWR	Root to shoot ratio		Fibrous roots/gm tap root	
	55 DAP	55 DAP	132 DAP	55 DAP	132 DAP
MHE-4	0.52	0.53	1.43	33.5	1.9
SR-87	0.51	0.50	2.21	32.4	1.3
Row Spacing					
10 in	0.48_b	0.48_b	1.84_a	32.8	1.1
16 in	0.51_{ab}	0.52_{ab}	1.80_a	21.8	1.0
22 in	0.55_a	0.55_a	1.81_a	15.9	1.1

Table 3. Yield components of two sugarbeet cultivar responses to three row spacings (n=4).

Variety	Row spacing in	Harvest index	Yield T/A	Sucrose %	RWSA lbs/A	Clear juice purity %
MHE-4	10	0.58_b	17.3_c	17.3_a	5027_a	94.0_a
SR-87	10	0.69_a	25.2_a	15.2_b	6151_a	92.2_{bc}
MHE-4	16	0.58_b	20.1_{bc}	15.7_b	5127_a	92.5_b
SR-87	16	0.68_a	27.4_a	14.3_{bc}	6096_a	91.2_{cd}
MHE-4	22	0.59_b	21.7_b	15.1_b	5259_a	92.1_{bc}
SR-87	22	0.68_a	27.8_a	13.3_c	5602_a	90.0_d

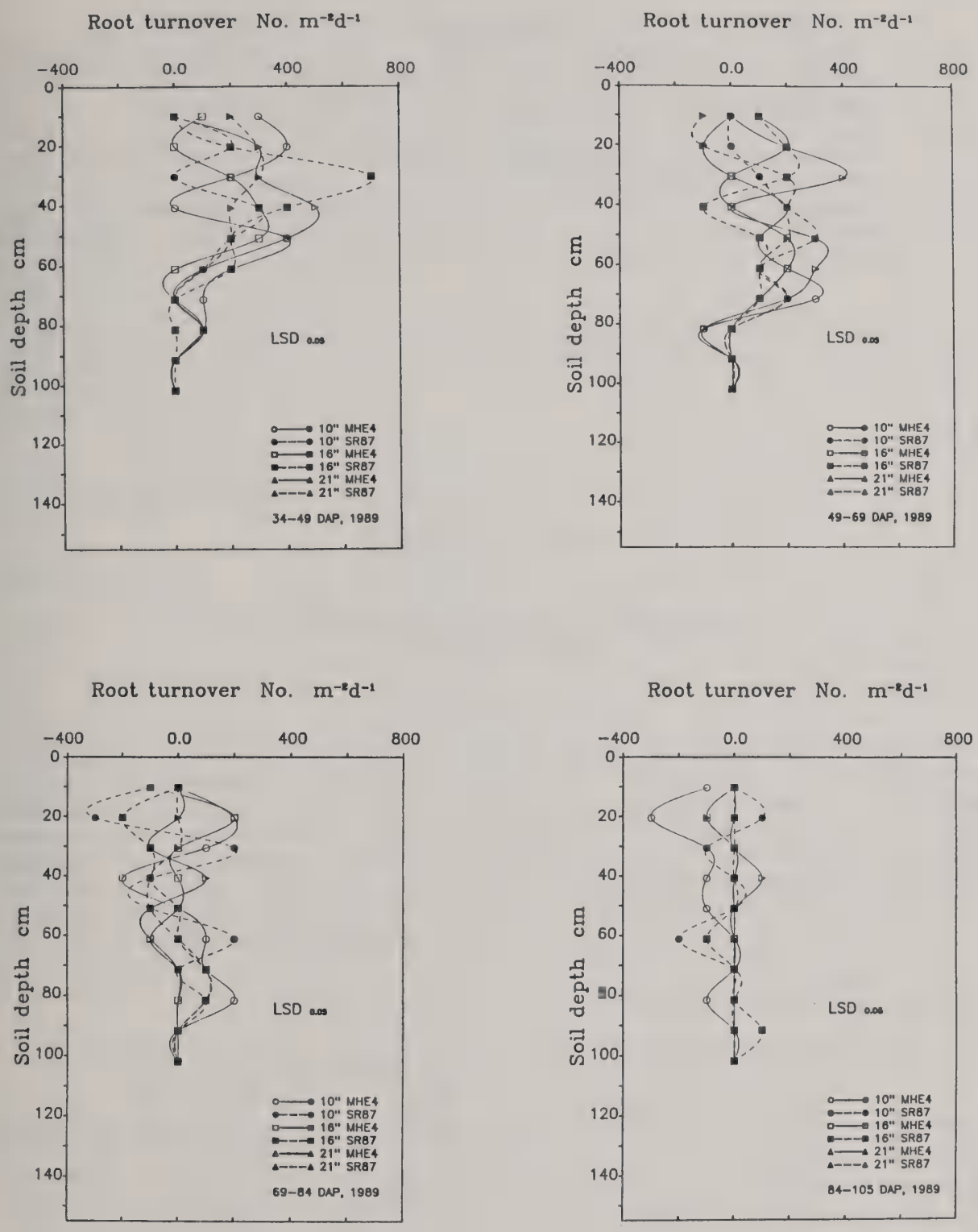

Figure 1. Fibrous root turnover (growth and death) in 0-100 cm soil depth for two sugarbeet cultivars at three row spacings, measured at 34, 49, 69, 84, and 105 DAP.

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SELECTION FOR HIGH SURCOSE PERCENTAGE IN SMOOTH ROOT BEETS

J. C. Theurer

The sugar percentage of smooth root germplasm has tended to be high in root yield and 1-2% lower in sucrose percentage compared to present commercial cultivars. Two approaches have been made to increase the sucrose content of the SR lines: (1) individual beet selection for high sucrose within SR germplasm and (2) outcrossing SR material to high sugar lines and subsequent selection for high sugar plants. A comparison of the ranges and mean sugar percentage of individual smooth root beet selections are given in Table 3 Where HS = outcrossing and H = selection within SR families.

Table 3. Smooth Root High Sucrose Selections

	No. Lines	Sucrose % Range	Mean
88HS	45	12.42-18.46	15.58
89HS	27	13.81-18.33	17.24
89H	19	13.55-16.43	14.53
MHE4		15.32-17.55	16.53
ACH167		15.83-18.53	17.18

SELECTION AND DEVELOPMENT OF SMOOTH SUGARBEET VARIETIES

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Two experiments were conducted in 1989 to evaluate the development of smooth root (SR) varieties of sugarbeet. Both experiments were conducted on the Douglas Fischer farm at Breckenridge, Michigan, on Bixbiro fine sandy loam soil.

The objective of Experiment 8915 was to evaluate the agronomic performance of SR experimental hybrids and to compare them with smooth-root genotypes and standard commercial cultivars for smoothness of root and the quantity of soil harvested with the root. This experiment was a repeat of the 1988 Experiment 8820.

The objective of Experiment 8916 was to evaluate the agronomic performance and smoothness of root of selected SR progenies and to make additional SR selections from these progenies.

Materials and Methods

Experiment 8915:

Three U.S. commercial cultivars, 2 smooth root lines, a commercial smooth root variety produced in Holland (Univers) and 4 F_1 hybrids having SR87 as a pollen parent were included in the field trial (see Table 1). SR87, the pollinator of all of the F_1 hybrids, is our best smooth root line. The 10 entries were planted in 6 replications of a randomized block design. Individual plots consisted of 2 rows 28" (71 cm) apart and 30' (9 m) in length. The experiment was planted April 25, 1989 and was thinned to single plants 8-12" (20-30 cm) within the row on June 6-7, 1989. Harvest was made October 16-17, 1989 using an experimental mini-harvester with puller wheels and a series of rotating star rinks similar to those for a conventional sugarbeet harvester. Beets were bagged and transported to the laboratory at the B & B Research Farm. Soil was scraped from the roots, and both the cleaned roots and soil quantity was weighed. Each root was scored for smoothness on a 1 to 5 scale defined below:

1 = Very smooth taproot, no grooves, broad fibrous root zone
2 = Smooth, slightly grooved taproot, narrow fibrous root zone
3 = Partially smooth, grooved, heavy fibrous non-branching taproot
4 = Rough shaped taproot, deep grooves, heavy fibrous roots with some sprangling
5 = Very rough, very deep grooved, multiple branched taproot

A 10-beet sample from each field plot was sawed with a 10-blade Spreckles saw to obtain brei for lab analysis. Sucrose percentage and clear juice purity was determined on the pressed juice from each brei sample, at the Michigan Sugar Company Research Lab at Carrollton, MI, using standard analysis techniques.

Experiment 8916:

Twenty-one smooth root selections and 3 commercial varieties were included in this experiment. The study consisted of 4 replications of single row plots with rows 28" (71 cm) apart and 30' (9 m) in length. Planting, thinning, and harvest were accomplished on the same dates as listed above for Experiment 8915.

Results

This year there was a relatively good stand of beets after emergence and after thinning. There was some stand depletion during the year due to Rhizoctonia root rot, but this was a minor problem compared to the warm dry 1988 season. There was a heavy incidence of Cercospora leafspot in 1989 and susceptible varieties as Univers had considerable leaf loss due to this disease. The plots were scored for leafspot resistance just prior to harvest on October 16, 1989. A stand count was also taken at harvest and an adjustment was made to correct stand losses in each plot. The soil was slightly moist and provided an ideal condition for machine harvest and critical comparison of standard type versus smooth root type sugarbeets.

Table 1 lists the means for root and sucrose yield, sucrose percentage, clear juice purity percent, smoothness score, and soil harvested with roots for commercial hybrids, smooth root lines, and hybrids in Experiment 8915. One SR87 hybrid [code 7- (6926/607 x SR87)] had equal recoverable white sugar per acre (RWSA) to MHE4 and ACH176 commercial cultivars. The other three hybrids averaged approximately 940 pounds less RWSA. Three hybrid showed root yield above that of MHE4 but differences for all 10 lines in the test were not significant for this character. The commercial varieties had significantly higher recoverable white sugar per ton (RWST) and sucrose percent than the SR hybrids. With the exception of the 85576 CMS x SR87 hybrid (code 9), the checks were also superior for CJP percent.

As expected the two smooth root lines were far superior to the other varieties in the experiment for smooth root scores and the quantity of soil harvested with the beets. They averaged less than 20% of the soil harvested with MHE4 and ACH176. The four SR87 hybrids averaged 40% less soil with a range of 26% to 50% less. SR hybrids also had significantly smoother roots than the check cultivars.

The European smooth root hybrid, Univers, (code 3) was similar to the U.S. commercial hybrids for all of the characters being studied. Univers could be visually identified in each replicate of the experiment due to its serious necrosis and loss of leaf foliage caused by Cercospora. Tap roots of this variety were also badly scored with Rhizoctonia root rot in some plots, thus the high root smoothness score may not be a true comparison with the scores given other varieties. As an entry in an agronomic field test at the B & B Farm, Univers was not affected by Rhizoctonia and showed root type similar to ACH176. It was evident that the roots of Univers do not have the absence of a groove in the root as our SR87 and 85700 smooth root genotypes.

Agronomic performance, smoothness score, and soil harvested with the roots for Experiment 8916 is shown in Table 2. All SR entries had significantly less soil harvested with the roots (range = 13% to 34% of ACH176). Univers (code 3) showed significantly lower soil than the U.S. commercial cultivars. The smoothness of root score was not different from ACH176 and MHE4 in this experiment. Seventeen SR lines had significantly lower scores for smoothness. Seven of the SR lines were significantly lower in RWSA than the checks. All but two SR lines equalled the commercial hybrids in root weight, and only one SR entry had lower CJP percent. Only one SR line had sucrose percentage equal to the checks and three SR lines were not statistically different than the checks for RWST. We selected 101 individual beets from these lines for continued breeding.

The inverse relationship between high root yield and sucrose content is evident in the data from these experiments. The greatest challenge remains-to get high sucrose into SR beets.

Table 1. Means for root and sugar yield, sucrose percent, clear juice purity percent, smoothness score, quantity of soil harvested with beets, and average leafspot reading for commercial hybrids, smooth root (SR) lines, and SR hybrids. 1989 Experiment 8915. Breckenridge, MI.

List Of Variables

Var	Type	Name / Description
1	NUMERIC	VARIETY CODE NO.
2	TEXT 10	VARIETY SEED NO.
4	NUMERIC	RWSA
5	NUMERIC	RWST
6	NUMERIC	TONS/ACRE
7	NUMERIC	SUCROSE %
8	NUMERIC	CJP %
9	NUMERIC	SMOOTHNESS AVERAGE SCORE
11	NUMERIC	POUNDS SOIL PER TON OF BEETS HARVESTED
12	NUMERIC	AVERAGE LEAFSPOT READING

1	2	4	5	6	7	8	9	11	12
Commercial Cultivars									
1	MHE4	8487.0	293.7	28.9	17.49	94.04	3.45	107.6	2.00
2	ACH176	8105.0	294.6	27.5	17.52	94.15	3.46	117.5	3.33
3	USH23	7372.0	267.2	27.5	15.99	94.05	3.45	128.7	3.33
Smooth Root Lines									
4	85700	6421.0	235.1	27.3	14.42	93.03	2.41	19.4	3.00
5	SR87	6620.0	231.9	28.5	14.40	92.42	2.17	19.9	3.00
6	UNIVERS	6216.0	226.3	27.3	14.13	92.17	3.29	41.1	5.17
CMSxSR87 Hybrids*									
7	WC87016	7599.0	251.3	30.2	15.15	93.77	2.87	41.3	2.33
8	WC87017	7098.0	237.7	29.9	14.52	93.21	2.82	29.8	3.00
9	WC87018	7375.0	266.2	27.6	15.85	94.33	3.13	56.5	2.50
10	WC87019	7478.0	250.6	29.9	15.35	92.91	2.98	53.6	2.33
	MEAN	7277.0	255.4	28.5	15.48	93.41	3.00	61.6	3.00
	LSD .05	892.1	13.1	3.1	0.72	0.61	0.19	15.0	0.63
	CV	10.5	4.4	9.3	4.03	0.56	5.52	21.0	17.9

*Hybrid description:
WC87016 = (SP6926/FC607) x SR87
WC87017 = EL36C2 x SR87
WC87018 = SP85576-01 x SR87
WC87019 = SP85657-01 x SR87

Table 2. Means for root and sugar yield, sucrose percent, clear juice purity percent, smoothness score, quantity of soil harvested with beets, and average leafspot reading for smooth root selections. 1989 Experiment 8916. Breckenridge, MI.

List Of Variables

Var	Type	Name / Description
1	NUMERIC	VARIETY CODE NO.
2	TEXT 10	VARIETY SEED NO.
4	NUMERIC	RWSA
5	NUMERIC	RWST
6	NUMERIC	TONS/ACRE
7	NUMERIC	SUCROSE %
8	NUMERIC	CJP %
9	NUMERIC	SMOOTHNESS AVERAGE SCORE
11	NUMERIC	POUNDS SOIL PER TON OF BEETS HARVESTED
12	NUMERIC	AVERAGE LEAFSPOT READING

1	2	4	5	6	7	8	9	11	12
1	MHE4	7426.0	271.8	27.5	16.63	92.82	3.35	126.0	1.50
2	ACH176	7309.0	278.8	26.1	16.78	93.64	3.27	180.0	3.25
3	UNIVERS	5904.0	221.2	26.6	14.09	91.23	3.23	37.5	5.00
4	88H1-00	5607.0	263.2	21.1	16.07	92.99	3.05	43.0	2.25
5	88H2-00	5149.0	246.6	20.8	15.38	92.09	2.80	39.5	3.00
6	88H3-00	5915.0	237.7	24.8	14.74	92.42	2.39	24.2	3.00
7	88H4-00	6957.0	238.5	29.2	14.67	92.85	2.68	17.0	3.25
8	88H5-00	6909.0	235.6	29.3	14.72	92.15	2.65	27.0	3.00
9	88H6-1	6602.0	257.7	25.6	15.71	93.14	2.98	25.9	2.00
10	88H6-2	5852.0	251.3	23.4	15.38	92.96	2.25	25.1	2.00
11	88H6-7	6639.0	248.4	26.8	15.23	92.86	2.33	23.0	1.50
12	88H7-4	6154.0	219.1	28.1	13.84	91.68	2.22	21.3	3.00
13	88H8-1	6413.0	229.7	27.9	14.50	91.67	2.49	20.3	2.75
14	88H8-4	5396.0	221.4	24.4	14.45	90.12	2.66	28.5	2.25
15	88H13-10	6515.0	244.6	26.7	15.12	92.54	2.71	20.5	2.25
16	88H13-18	5632.0	226.8	24.8	14.35	91.57	2.27	31.5	2.75
17	88H13-20	6324.0	233.8	27.1	14.62	92.11	2.58	30.7	3.00
18	88H15-2	6604.0	242.5	27.2	14.84	93.09	2.51	19.5	2.25
19	88H15-6	5579.0	222.7	24.8	13.94	92.10	2.45	21.3	2.25
20	88H17-4	5360.0	209.6	25.6	14.48	88.51	2.32	31.8	2.75
21	88H19-6	5827.0	226.9	25.5	14.49	91.10	2.50	41.3	2.25
22	88H19-7	6241.0	227.3	27.5	14.47	91.29	2.59	29.0	2.50
23	88H41-1	5751.0	237.7	24.2	14.61	92.88	2.80	33.1	2.25
24	88H56-5	7378.0	248.0	29.6	14.98	93.91	2.53	27.3	2.50
	MEAN	6227.3	239.2	26.0	14.92	92.16	2.66	38.6	2.60
	LSD .05	1314.0	25.6	4.5	0.93	2.96	0.49	18.9	0.93
	CV	15.0	7.6	12.3	4.44	2.28	13.0	34.7	25.23

ROW SPACING AND PLANT DENSITY EFFECTS OF SMOOTH ROOT SUGARBEETS

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Smooth root (SR) sugarbeets have the advantage over present day varieties of ease of harvest, less wear on harvest machinery, less soil to transport, less bruising of the root, and better storageability in piles awaiting processing. We have developed breeding lines with relatively smooth, non-grooved taproots, and in a few years, we could be growing smooth-root cultivars. With the recent emphasis on narrow rows, it is apparent that we also need to know how smooth root types respond to density in closer row spacings.

Two field experiments were grown in 1989 designed to compare the production of smooth root lines with that of adapted commercial varieties under different spatial arrangements in the field.

Materials and Methods

Experiment 899:

This experiment was a repeat of a 1988 plant density study. Two smooth root lines of sugarbeet (SR87 and 87H1-00) and 2 commercial cultivars (MHE4 and ACH176) were planted at the B&B Research Farm in a split-plot randomized experiment of 6 replications on April 20, 1989. Individual plots were planted between tractor wheel tracks spaced 84" (2.14 m) apart. Three plant spacings were used: (1) Conventional 28" (71 cm) row width with plants spaced 8" (20 cm) apart within the row: (2) Rows 20" (52 cm) apart with 8" (20 cm) within row plant spacing; and (3) Plants in rows 14" (35.2 cm) apart with a single beet every 14" (35.2 cm) within the row. Plant density for these spacings would be approximately 28,000, 39,200, and 32,000 plants/acre for the 28", 20", and 14" row spacings, respectively. Each individual plot was 30' (9 m) long. The 28" plots consisted of 3 rows, the 20" of 4 rows, and the 14" of 5 rows. The experiment was harvested on September 28 by hand-digging all of the roots in the center rows of each plot. The outside 2 rows of each plot served as borders and were not harvested. Roots were weighed and a 10-beet sample was taken from each plot for sucrose and purity analysis. Root weights were adjusted to the same plot size or land area.

Tops were removed from the roots, and roots and top fresh weights were determined. A 10-beet root sample was taken from each plot for sucrose and purity analyses. Three tops and a sample of root brei from each plot was dried in an 85^{o}C oven for 72 hours to determine the dry matter percentage and calculate the total dry matter produced by each variety in each spacing. Data was analyzed using the MSTAT statistical program.

Experiment 898:

In this experiment, SR87 and MHE4 were compared in three between row spacings and two within row spacings in a split-plot randomized experiment of 6 replications. The planting was made on April 29, 1989, by seeding plots between tractor wheel tracks spaced 84" (2.14 m) apart. The six

spacing treatments were as follows:

Treatment	Spacing between rows	Spacing between plants within rows	Approximate no. Plants/acre
1.	28" (71 cm)	12" (30 cm)	18,700
2.	28"	6" (15 cm)	37,300
3.	22" (56 cm)	12"	23,800
4.	22"	6"	47,500
5.	18" (46 cm)	12"	29,000
6.	18"	6"	58,100

Each individual plot was 30" (9 m) in length. The 28" plots consisted of three rows, and the 22" and 18" had 4 row plots. The experiment was dug by hand on October 11, 1989. All roots in each plot were weighed. Then roots less than 1 3/4" (4.5 cm) in diameter were removed, and the balance of the roots were reweighed. This latter weight represents the root weight that would be realized with machine harvest since small roots are not picked up by the harvester. The high density plots had the greatest number of small roots. The root weights given in the tables in this report were also adjusted to an equal land area (70 sq ft or 6.5 sq m) for the 28", 20", and 14" row spacings. A 10 beet sample was taken from each plot for sucrose and purity analyses. Laboratory analyses were made by Michigan Sugar Company using standard clear juice methods. Data was analyzed and summarized using MSTAT statistical program.

RESULTS

There was an excellent stand of beets in both experiments immediately after emergence and after thinning was completed on June 29. However, due to heavy spring rainstorms, plants were larger and had experienced considerable inter-row competition before they could be singled. This competition may of had an adverse effect upon yield, especially for the 14" x 14" plots. Very few plants showed Rhizoctonia root rot symptoms this year in contrast to the estimated 6% yield loss due to this disease in 1988.

Experiment 899:

Variety means, row spacing means and variety x row spacing interaction means for Experiment 899 are given in Table 1. Sugarbeets grown in 20" rows had significantly greater root weight (approximately 1.5 tons/acre more), and produced more root dry matter than those grown in 28" rows. The 20" plots also showed a trend for higher recoverable sugar per acre (RWSA), recoverable sugar per ton (RWST), sucrose percent, and clear juice purity (CJP) than the 28" plants, but differences were not significant at the 0.05 level. Significant differences were noted for varieties for all variables measured. One or both of the commercial cultivars were superior to the SR germplasm for RWST, RWSA, and Sucrose percent. The SR lines had significantly higher root yield and root/top dry weight ratio with SR87 exceeding the commercials by more than three tons per acre. There were essentially no variety x spacing interactions as varieties behaved similarly in the three spacings. The results of this experiment were very similar to those obtained in the 1988 experiment with the same four varieties.

Experiment 898:

Means for the performance of MHE4 and SR87 smooth root variety grown in 18", 22" and 28" row widths with 6" and 12" between plants within rows are given in Table 2. In general sugarbeets grown in narrower row widths had higher yield, higher sucrose, and better purity than those produced with standard 28" row width. The 18" and 22" row plantings with 12" spacing between plants within the row were significantly better than those grown in 28" rows, for RWSA, tons/acre, and clear juice purity. The 18" and 22" treatments also had the highest RWST and sucrose percentage. The 6" within row plant density was more favorable than the 12" density for increasing sucrose percentage and RWST. However, the 18" row spacing showed a tendency in the opposite direction.

There is no doubt that there is an optimum plant population density for maximum sugar yield. The 18" row spacing at 12" density of plants within the row (29,000 plants/acre) was significantly the best treatment in the experiment for root yield and RWSA, whereas the 18" rows at 6" density (58,100 plants/acre) was significantly the lowest yielding treatment in the test. The plants at the high density planting evidentially had too much competition for light and nutrients to have optimum growth and sucrose storage. The data also demonstrates that 28" row spacing with 12" between plants within the row (18,700 plants/acre) is not a sufficient plant density for obtaining maximum sugar yield.

With a few exceptions the two varieties, MHE4 and SR87 behaved similarly under different plant densities. SR87 had better yield than MHE4 under high plant density populations (58,100 plants/acre). SR87 also had significantly higher tons/acre than MHE4 at every row spacing and plant density in the test. Conversely, MHE4 was significantly higher than SR87 in RWST and sucrose percentage at every row spacing and plant density.

Table 1. Mean root and sugar yield, sucrose percentage, and clear juice purity percentage for two commercial cultivars and two smooth root (SR) lines in three plant densities. 1989 Experiment 899.

List Of Variables

Var	Type		Name / Description
1	TEXT	8	VARIETY
2	TEXT	4	ROW SPACING
3	NUMERIC		RWSA
4	NUMERIC		RWST
5	NUMERIC		TONS/ACRE
6	NUMERIC		SUCROSE %
7	NUMERIC		CJP%
11	NUMERIC		R/T RATIO DRY WT.
12	NUMERIC		DRY WT. TOPS lbs.
13	NUMERIC		DRY WT. ROOTS lbs.

	1	2	3	4	5	6	7	11	12	13
Variety Means										
MHE4			6550.0	251.6	26.0	14.96	94.52	2.30	6.90	15.50
ACH176			6952.0	268.0	25.9	15.88	94.54	2.30	7.10	16.10
SR87			6578.0	222.2	29.6	13.52	93.58	2.60	6.10	15.40
87H1-00			6068.0	233.9	26.0	14.05	94.15	2.30	6.00	13.90
LSD .05			254.3	7.3	0.9	0.35	0.38	0.14	0.31	0.64
Row Spacing Means										
		28"	6377.0	245.1	26.1	14.66	94.23	2.30	6.60	14.90
		20"	6762.0	245.8	27.6	14.69	94.27	2.30	6.80	15.60
		14"	6472.0	240.9	27.0	14.45	94.10	2.50	6.10	15.10
LSD .05			464.3	8.2	1.3	0.39	0.34	0.17	0.29	0.76
Variety x Row Spacing Means										
MHE4		28"	6388.0	248.5	25.7	14.77	94.59	2.20	7.20	15.30
MHE4		20"	6857.0	255.1	26.9	15.19	94.38	2.20	7.30	16.20
MHE4		14"	6405.0	251.3	25.5	14.92	94.59	2.50	6.10	15.10
ACH176		28"	6952.0	272.9	25.0	16.11	94.70	2.20	7.10	15.70
ACH176		20"	7106.0	266.0	26.7	15.80	94.40	2.20	7.50	16.50
ACH176		14"	6938.0	265.2	26.1	15.73	94.52	2.40	6.70	16.00
SR87		28"	6412.0	219.7	29.2	13.40	93.48	2.40	6.20	14.90
SR87		20"	6738.0	228.6	29.7	13.81	93.88	2.50	6.20	15.70
SR87		14"	6538.0	218.4	29.9	13.36	93.38	2.70	5.70	15.50
87H1-00		28"	5895.0	239.4	24.7	14.36	94.13	2.40	5.80	13.80
87H1-00		20"	6303.0	233.6	27.0	13.97	94.41	2.20	6.40	14.00
87H1-00		14"	6007.0	228.6	26.3	13.81	93.90	2.40	5.80	13.80
MEAN			6537.0	243.9	27.0	14.60	94.20	2.37	6.50	15.21
LSD .05			440.5	12.6	1.5	0.60	0.66	0.24	0.64	1.11
CV			5.8	4.4	4.9	3.52	0.60	8.74	8.51	6.29

Table 2. Mean root and sugar yield, sucrose percentage, and clear juice purity percentage for MHE4 commercial cultivar and SR87 smooth root line grown at different row widths and plant densities. 1989 Experiment 898.

List Of Variables

Var	Type		Name / Description
1	TEXT	8	VARIETY
2	TEXT	4	ROW SPACING
3	TEXT	4	PLANT DENSITY
4	NUMERIC		RWSA
5	NUMERIC		RWST
6	NUMERIC		TONS/ACRE
7	NUMERIC		SUCROSE %
8	NUMERIC		CJP %

	1	2	3	4	5	6	7	8
Variety Means								
MHE4				5824.0	275.0	21.2	16.26	94.58
SR87				6340.0	243.3	26.1	14.73	93.62
Row Spacing Means								
	28"			5845.0	257.2	22.8	15.43	93.94
	22"			6228.0	257.5	24.4	15.42	94.03
	18"			6172.0	262.7	23.7	15.63	94.33
LSD .05				312.5	5.6	1.2	0.28	0.26
Variety x Row Spacing Means								
MHE4	28"			5638.0	270.3	20.9	16.11	94.20
MHE4	22"			6146.0	278.1	22.1	16.37	94.80
MHE4	18"			5688.0	276.6	20.6	16.31	94.74
SR87	28"			6053.0	244.0	24.8	14.75	93.69
SR87	22"			6310.0	237.0	26.6	14.47	93.25
SR87	18"			6656.0	248.9	26.8	14.96	93.93
LSD .05				375.9	6.2	1.5	0.27	0.43
Variety x Row Spacing x Density Means								
MHE4	28"	12"		5685.0	268.4	21.2	16.06	93.98
MHE4	28"	6"		5591.0	272.3	20.6	16.16	94.42
MHE4	22"	12"		6299.0	271.5	23.2	16.11	94.42
MHE4	22"	6"		5993.0	284.6	21.1	16.63	95.18
MHE4	18"	12"		6307.0	276.4	22.8	16.33	94.65
MHE4	18"	6"		5069.0	276.8	18.3	16.29	94.83
SR87	28"	12"		6029.0	242.6	24.9	14.69	93.60
SR87	28"	6"		6077.0	245.3	24.8	14.80	93.77
SR87	22"	12"		6423.0	235.5	27.3	14.41	93.11
SR87	22"	6"		6197.0	238.6	26.0	14.52	93.39
SR87	18"	12"		7035.0	250.5	28.1	15.02	94.04
SR87	18"	6"		6277.0	247.2	25.4	14.90	93.81
MEAN				6081.8	259.1	23.6	15.49	94.10
LSD .05				531.6	8.8	2.1	0.38	0.61
CV				7.5	2.9	7.7	2.12	0.56

SUGARBEET RESEARCH

1989 Report

Section F

University of Idaho
Parma, Idaho

Dr. S. L. Hafez

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CONTENTS

Non-Chemical Means to Reduce the Sugarbeet Cyst Nematode Population and Minimizing Yield Losses

Saad L. Hafez

"Nematode, a small microscopic worm, but it can be a serious problem for sugarbeet production." There are at least more than a dozen different nematode species which have been reported to cause severe economic damage to sugarbeets wherever they are grown commercially. In Idaho and eastern Oregon there are at least five different species which can be of economic importance if they were to be mismanaged. The yield loss to sugarbeets can be in the range of 10-80% depending on the nematode type and initial populations present in the fields at planting time.

These five nematode species are:

1. Sugarbeet cyst nematode - *Heterodera schachtii*
2. Northern Root-knot - *Meloidogyne hapla*
3. Columbia Root-knot - *M. chitwoodii*
4. Stubby Root - *Paratrichodorus* or *Trichodorus* spp.
5. Stem Nematode - *Ditylenchus dipsaci*

Nematologists and plant pathologists generally agree that sugarbeet cyst nematode is the major pest affecting sugarbeet production in the world and in general accounts for more than 90% of the total loss caused by all nematodes.

Sugarbeet production has been terminated in Utah and Washington largely because of heavy infestations by the sugarbeet cyst nematode which has made it impossible to grow sugarbeets economically in these states.

Historically, the spread of the sugarbeet cyst nematode has coincided with the expansion of sugarbeet production to new areas. The nematode was first observed in the United States as early as 1895. By 1907 it had been found in California, Utah, Colorado and Idaho. Today sugarbeet cyst nematodes are present in 17 states of the United States and in 40 different countries. Nematode distribution pattern in a field and throughout the soil profile is influenced by the age of infestation. Thus, in recently infested fields nematode distribution is usually in small patches and the highest nematode populations will be in the top soil (0-15 cm). In older infestations the nematodes occur in an almost uniform pattern and at much greater depth (0-50 cm). In general, the highest population usually occurs about 5-25 cm below the soil surface.

In Idaho and eastern Oregon the sugarbeet cyst nematode has been recognized as one of the most serious problems for the sugarbeet industry. It is, in fact, one of the most important limiting factors for sugar-beet production. Growers must choose between a long rotation practice using non-host plants or applying

expensive nematicides to obtain optimum yield in nematode infested fields. In Idaho and eastern Oregon more than 50% of the sugarbeet acreage is infested with sugarbeet cyst nematodes at a level where treatment is a must to obtain economically feasible yield.

The damage caused by this nematode depends on the initial nematode population density, and on the general soil and climate conditions which influence the growth of the host plant and the nematode survival. In areas of intensive sugarbeet production and short rotations, it is impossible to grow a profitable crop without expensive nematicide application.

In warmer climates with a longer growing season the loss can be higher because the nematode damage is often increased by secondary pathogens. For example, in Idaho, infection with sugarbeet cyst nematode often aggravates damages caused by Rhizoctonia, a fungus disease.

Because of the strict EPA regulations on existing nematicides and the new ones, and the increasing cost of chemical control, there is a need for developing an alternative control tactic for sugarbeet nematodes.

Some of the alternative cultural and biological tactics under investigation are:

1. The use of green manure crop as soil amendment (e.g. nematode resistant oil radish variety).

2. The use of nematode resistance oil radish varieties in sugarbeet rotation as a trap crops to control the sugarbeet cyst nematode.

3. The use of rapeseed oil meal. Meal extracted for high glucosonulate variety contained chemicals similar to the active ingredient of the nematicide vapam.

Accomplishments

1. The effect of different nematode resistance oil radish varieties on sugarbeet cyst nematode populations.

   It is known that host root exudate stimulate hatching of the cyst nematode. If the eggs hatch and there is no susceptible host for larvae to feed on, they will die from starvation.

   Most of the radish family plants are considered hosts to the sugar beet cyst nematode. Some of the radish varieties have been found to be resistant to this nematode and can be used as a trap crop. Several varieties developed in Germany were found to stimulate cyst nematode hatching but does not provide all of the nutrients required for female development.

Table 1. The effect of nematode resistant oil radish and mustard varieties on sugarbeet cyst nematode population (1989) ID.

Crops and Varieties	Nematode Population in 500 cc Soil 1/				
	Mature	Young Cyst	# of Egg per Cyst	Total # of Cyst	Males Egg & Larvae
Oil Radish Var. Pegletta	3.1	0.5	83.5	467.7	258
Oil Radish Var. Nemex	6.3	0.8	94.6	841.8	141
Mustard Var. Maxi	6.6	0.2	92.2	804.6	25
No Plant	8.8	0.0	114.0	1388.6	0
Sugarbeet	84.3	49.5	168.6	17,280.0	116

1/ Average of 10 replicates.
Preplant nematode population: Viable Cyst = 16
No. of Eggs/Cyst = 148
Total No. Eggs/500 cc soil = 2368

Table 2. The effect of nematode resistant oil radish and mustard varieties on sugarbeet cyst nematode population (1989) ID.

Crops and Varieties	Nematode Population in 500 cc Soil 1/		
	Total # of Egg & Larvae	Male	% Reduction
Oil Radish Var. Pegletta	467.7	258	-80
Oil Radish Var. Nemex	841.8	141	-64
Mustard Var. Maxi	804.6	25	-66
No Plant	1388.6	0	-41
Sugarbeet	17,280.0	116	+630

1/ Average of 10 replicates.
Preplant nematode population: Viable Cyst = 16
No. of Eggs/Cyst = 148
Total No. Eggs/500 cc soil = 2368

The preliminary result of the ongoing research in Idaho at the Parma Research and Extension Center indicated that planting these nematode resistant oil radish varieties in soil infested with sugar beet cyst nematodes will reduce the cyst nematode population significantly in comparison to no-plant. Nematode larvae can develop into females or males depending on certain conditions during their development. There are indications that these oil radish varieties disrupt the normal development of larvae to become females, thus resulting in an unusually high number of males. Nematode larvae can develop into females or males depending on certain conditions during their development (Tables 1 and 2).

2. The effect of rape seed oil meal on sugarbeet plant growth and cyst nematode population.

   The results from several greenhouse tests and one field trial showed that rape seed meal stimulated the growth of sugarbeet plants growing in soil heavily infested with sugarbeet cyst nematode. Cyst nematode populations in treated soil were not significantly different from the untreated soil. However, the number of mature cysts in treated soil was lower than in untreated soil. Further study is needed to determine the mode of action of rape seed oil meal on sugarbeets (how the rape meal affects the plant and the cyst nematode) (Table 3).

Table 3. The effect of fumigant, non-fumigant nematicides and rape meal on sugarbeet yeild growing in fields infested with sugarbeet cyst nematodes. Parma, 1988.

Treatment	Rate/A	Application* Method	Application* Date	Yield T/A	Yield Increases
Telon II	18G	B.C. 12-14" deep	10/31/87	37.5	8.6
Telon II	9G	In Bed 12-14" deep	10/31/87	35.7	6.8
Temik 15 G	33 lbs	B.C.I	11/3/87	30.2	1.3
Rape Meal	2 T	B.C.I	11/3/87	33.0	4.1
Untreated	---	---	---	28.9	---

LSD at 5% = 2.5 T/A
Average nematode population before treatment = 2.5 eggs/1 cc soil
Number of Replications = 5 replications/treatment in complete randomized block

*B.C.I = Broadcast Incorporated
B.C. = Broadcast

SUGARBEET RESEARCH

1989 Report

Section G

Texas A & M University
Bushland, Texas

Dr. C. M. Rush

The research was supported in part by funds provided through the Texas A&M University and the Beet Sugar Development Foundation (Project 110, 130 and 990).

CONTENTS

PUBLICATIONS

Abstracts of Papers Published or Approved for Publication.

Baker, E. M. and C. M. Rush. 1988. Reaction of selected sugar beet varieties exposed to two pathogenic *Pythium* spp. Phytopathology 78:1566.

In the Texas Panhandle, two *Pythium* spp. designated P2 and P34 have been consistently isolated from diseased sugar beet seedlings. Four cultivars, two experimental varieties, and a commercially primed cultivar were evaluated for their reaction to the two *Pythium* isolates. Seed were planted in artificially infested soil and incubated for two weeks at 25C in growth chambers. None of the varieties showed significant resistance to either isolate as determined by percent emergence and damping off, but there were significant differences between the primed and unprimed TX18. Primed seed had better emergence in both infested soils and more resistance to post-emergence damping off in P2 infested soil than nonprimed seed. There were also significant differences between isolates. P34 is much more virulent and appears to cause more preemergence damping off than P2.

Baker, E. H. and C. M. Rush. 1989. Reaction of selected sugar beet varieties exposed to two pathogenic *Pythium* spp. J. of Sugarbeet Res. 26:A2.

In the Texas Panhandle, two *Pythium* spp. designated P2 and P34 have been consistently isolated from diseased sugar beet seedlings. The isolates do not form sexual structures and may be heterothallic species or sterile strains of *P. ultimum*. P34 is more virulent and causes more preemergence damping off than P2. Thirty cultivars were evaluated for their reaction to the two *Pythium* isolates. Seed were planted in artificially infested soil and incubated in a greenhouse for two weeks. The cultivars were evaluated for emergence and stand. Four varieties, American Crystal 146, USDA-USH 23, Holly 1434-03 and American Crystal C86, showed significant tolerance to the two pathogens. Mono-Hy varieties RH 83, D2, TX9 and TX18 also showed some tolerance.

Baker, E. H. and C. M. Rush. 1989. Preliminary studies on seed priming of sugar beet. J. of Sugarbeet Res. 26:A2.

Studies were conducted with primed and unprimed sugar beet seed (cv. Mono Hy Tx 18) under field and laboratory conditions to compare rates of emergence, damping off, and final stand. In field tests at five separate locations, seed were planted in thirty foot, two-row plots and replicated five times. Stand counts were made approximately three and ten days after the first seedlings emerged. Primed seed consistently emerged faster than unprimed seed, and the difference was statistically significant in three of the five fields. After one week, stand counts were not significantly different in any field. In a second study, primed and unprimed seed were evaluated for resistance to infection by two pathogenic *Pythium* spp. Seed were planted in artificially infested soil and incubated in the laboratory for two weeks in lighted growth chambers at 25 C. Emergence counts were taken after one week and final stand counts were taken at two weeks. Primed seed had significantly higher rates of emergence and better final stands in both treatments.

Martyn, R. D., C. M. Rush, C. L. Biles, and E. M. Baker. 1988. *Fusarium*

oxysporum, causal agent of root rot of sugar beets in the Texas Panhandle. Phytopathology 78:1544.

Sugar beets (*Beta vulgaris* L.) in the Texas Panhandle affected by a root rot disease had foliar symptoms resembling those of Fusarium yellows [*F. oxysporum* f. sp. *betae* (F.o.b.)]. Symptoms included interveinal chlorosis, wilt, and eventual collapse of the leaves. Cross sections of infected root and crown tissue showed extensive vascular discoloration. Additional symptoms not typically associated with Fusarium yellows occurred, however, and included a rot of the tap root that generally began at the distal end and proceded proximally. Lateral roots were also affected and served as the primary infection site. Isolations from diseased roots consistently yielded an atypical *F. oxysporum*. Greenhouse inoculations of sugar beets (cv. TX9) with each of two *F. oxysporum* isolates from diseased, field-grown sugar beets reproduced all of the field symptoms, including root rot after 5 months. Comparison of morphological features and isozyme patterns of several enzymes of the Texas isolates with F.o.b. indicated that the two organisms were distinct.

Martyn, R. D., C. M. Rush, E. H. Baker, and C. L. Biles. 1989. Etiology of root rot of sugar beet in Texas. J. Sugar Beet Res. 26:A16-A17.

Approximately 16,000 ha of sugar beets (*Beta vulgaris* L.) are grown in a four-county area in the panhandle of Texas and constitute a significant proportion of the agricultural economy in that region. A disease characterized by interveinal chlorosis of the leaves, wilting, vascular discoloration, and root rot has increased over the past 8 years to the point that it limits production in some fields. Symptomatically, the disease is similar to Fusarium yellows, caused by *Fusarium oxysporum* f. sp. *betae*; however, the severe root rot which occurs is not associated with Fusarium yellows. The rot typically begins at the distal end of the root, with black streaks radiating upward. In extreme instances, the infected portion of the root completely rots, leaving only remnants of the vascular bundles. *Fusarium oxysporum* was isolated consistently from internal root tissue of affected plants. Two separate tests with two isolates of *F. oxysporum* from diseased, field-grown sugar beets confirmed their pathogenicity and reproduced all disease symptoms on cultivar TX-9 in the greenhouse. Inoculations with two known isolates of *F. o.* f. sp. *betae* from California and one from Oregon did not cause root rot. Electron microscopy of infected root tissue revealed that both *F. o.* f. sp. *betae* and the Texas isolate readily colonized the vascular tissue.

Martyn, R. D., C. M. Rush, C. L. Biles, and E. H. Baker. 1989. Etiology of a root rot disease of sugar beet in Texas. Plant Disease 73:879-884.

A disease of sugar beet (*Beta vulgaris*) in Texas characterized by wilt and root rot has been shown to be caused by *Fusarium oxysporum*. The disease is similar to Fusarium yellows, caused by *F. o.* f. sp. *betae*, but is distinct in that a severe root rot also occurs that is not associated with Fusarium yellows. Scanning electron microscopy revealed that the pathogen inhabited the xylem, typical of Fusarium yellows. However, electrophoretic data on three enzymes (cinnamyl alcohol dehydrogenase, esterase, and glucose-6-phosphate dehydrogenase) revealed significant differences in isozymes produced between the Texas isolates of *F. oxysporum* and known isolates of *F. o.* f. sp. *betae*. The Texas sugar beet isolate may be a new forma specialis (or a new race of *F. o. betae*). However, further comparisons with additional isolates are necessary before a definite

conclusion can be made.

Rush, C. M. 1988. Soil fumigation with Telone II and Telone C-17 for control of sugar beet root rot diseases. Phytopathology 78:1562.

The predominant root rot pathogens of sugar beets grown in the Texas Panhandle include *Rhizoctonia solani*, *Fusarium oxysporum*, *Aphanomyces cochlioides*, and *Pythium* spp. Often, all four pathogens can be found in individual fields and therefore, cultural practices and resistant varieties do not provide sufficient disease control. In 1987, test plots four rows wide and 30 m long were fumigated with Telone II or Telone C-17 at rates of 93 and 187 ℓ/ha. Plant stand and seedling disease were not affected by either treatment but root rot was significantly reduced, and yield in kg/ha and percent sugar were both significantly increased over nonfumigated control plots. At equivalent rates, Telone II out performed Telone C-17. Telone C-17 at 93 ℓ/ha did not reduce root rot or increase yield when compared with the control but did significantly improve sugar content.

Rush, C. M., T. H. Marek, and E. H. Baker. 1989. Relationship between sugar beet root rot severity and percent reduction in sugar content. J. of Sugarbeet Res. 26:A19.

A sugar beet root disease rating system was developed to explore the relationship between root rot severity and sugar content. At harvest in 1987, 15-20 sugar beet samples were taken at random from each of 13 selected fields with varying levels of disease. Beets from individual fields were bulked and grouped according to a disease rating of 0-4. Subsamples (7-11 Kg) were collected from each rated group and analyzed for sugar content. Correlation coefficients of disease rating versus sugar content ranged from 0.60 to 0.96. Using mean sugar values of each disease category from the 13 fields, the percent sugar reduction in each category 1-4 compared to category 0 was determined. Regression analysis of 1st through 4th order polynomials and several logarithmic and semi-logarithmic models were used to evaluate the relationship between percent sugar loss and disease rating. The model of best fit was a 1st order polynomial with an ordinate intercept of zero. The coefficient of determination (r^2) of this model was 0.88. The model was sugarloss = 9.32 times the rating.

Rush, C. M. and S. R. Winter. 1989. Influence of previous crop on Rhizoctonia root rot. J. of Sugarbeet Res. 26:A19.

A field study was conducted to determine if previous crops affect disease development in the subsequent sugar beet crop. Alfalfa, cotton, sorghum, sunflower, or wheat, grown in monoculture for 2-3 years, or fallow ground, preceded the beet crop. Disease incidence and progression in the sugar beet crop were monitored by taking bimonthly counts of the number of dead plants in two 7.6-m lengths of row in each plot. Beets were planted on half of the area in 1987 and half in 1988. Even after five years out of beets high levels of disease developed in some plots. At the end of the season in 1987, beets following alfalfa had the highest incidence of disease, losing 47% of the crop to root rot. Beets on sorghum and wheat ground followed with losses of 41% and 38% respectively. Plots on cotton, fallow, and sunflower ground all had significantly less disease with 32, 22 and 22% losses. Differences in these three were not significant. In 1988, similar trends were observed. As of August

2, beets on ground preceded by wheat or sorghum had 66% or 64% stand loss, respectively. Thirty five percent of the stand was lost on alfalfa ground. Cotton, fallow, and sunflower once again proved to be the best for preceding beets with only 21, 16, and 14% stand loss, respectively. *Rhizoctonia solani* was the predominant pathogen both years. It is hypothesized that beets on cotton, fallow, or sunflower ground had less disease because of lower levels of crop residue in the soil compared with wheat, sorghum, and alfalfa.

Rush, C. M. and S. R. Winter. 1989. Previous crop effect on Rhizoctonia root rot of sugar beet, 1988. (Approved by TAES for publication in Biological and Cultural Tests for Control of Plant Diseases.)

Wheat, sorghum, cotton, alfalfa, and sunflower were grown in 40 row plots (30 x 15 m) for three consecutive years prior to planting sugar beets. There were three reps of each crop in addition to a fallow control, all arranged in a randomized block design. Each year before reaching maturity, the individual crops were shredded and the resulting residue removed. Sugar beets were planted 23 March 1988. Approximately two mo after crop emergence main plot areas were split into six - four row subplots. Three received irrigations every two wk and three were to receive irrigation every four to six wk but summer rain disrupted this schedule. The intent was to establish a "wet" and "dry" treatment for evaluating irrigation effects on disease development. Disease counts were taken 11 times during the growing season approximately every two wk. Counts were made on 7.5 m lengths of the center two rows of each subplot. Only plants which were wilted were counted as diseased and these were pulled and discarded. At harvest, 5 Oct 88 each four row 15 m subplot was harvested, and subsamples taken for sugar analysis. All data were subjected to ANOVA for a split plot design and means separated by Duncan's procedure P=0.05.

Early in the growing season beets in "wet" subplots grew more slowly than those in the dry plots. By the middle of the summer, this trend had reversed, and at harvest the wet treatment inclusive of all crop effects had significantly greater yields. Sugar percent was also higher in "wet" plots but disease was not affected. On an individual crop basis however, irrigation frequency affected disease incidence, sugar, and plot wt. Diseased plants were first observed in early June. The number of diseased plants increased rapidly through July, and then tapered off during August. This test was extremely successful and essentially confirmed observations made in 1987.

Yeh, Y., C. M. Rush, and S. D. Lyda. 1989. Inter- and intraspecific restriction fragment length polymorphisms in the genus Aphanomyces. J. of Sugarbeet Res. 26:A29.

Aphanomyces cochlioides Drechs. is a water mold that causes sugar beet black root. A comparative analysis of mycelial DNA was made from two isolates of the fungus from Texas, two isolates from Minnesota, and one isolate each from Michigan, California, The Netherlands and Sweden. DNA was isolated from mycelium using a modified procedure of Garber and Yoder (Anal. Biochem. 135:416-422). Restriction endonuclease enzymes were used to examine intraspecific variation of the fungal DNA. Fragment patterns were compared on agarose gels following electrophoresis of digested DNA. DNA from other species of *Aphanomyces* was studied by this technique to determine phylogenetic relationships based upon restriction fragment length polymorphisms.

GENETIC VARIATION AMONG FUSARIUM ISOLATES CAUSING ROOT ROT OF SUGAR BEET
(BSDF Project 110)

C. M. Rush and R. D. Martyn

Fusarium root rot is one of the most prevalent and damaging diseases of sugar beets in Texas. The disease is caused by *Fusarium oxysporum* f. sp. *betae*, but Texas isolates of fungus are morphologically different from typical *F. O.* f. sp. *betae* isolates (Paul Nelson and Carol Windel - Personal communication). Disease symptoms on roots are also different from typical Fusarium yellows in that a root rot occurs with the Texas isolate. These differences in fungal morphology and disease symptomology prompted a study using isozyme analysis to investigate genetic variation between *F. O.* f. sp. *betae* isolates causing typical yellows and those from Texas which cause root rot.

Three enzymes were used in the study, esterase, glucose-6-phosphate dehydrogenase, and cinnamyl alcohol dehydrogenase. Isozymes were separated using native polyacrylamide gel electrophoresis, standard staining procedures were used, and binomial analysis of banding patterns was applied to a hierarchical cluster analysis and Simpson's coefficient using BIOSTATE II.

In the first set of experiments, 20 isolates were examined (Fig. 1). On the basis of visual inspection for similarities and differences of each isolates isozyme pattern, eight isolates were selected for further study. These were electrophoresed a second time and a phenogram was constructed based on matching distances (MD) (Fig. 2). The smaller the MD the more closely related the isolates. Matching distances of 0 indicate no significant differences among isolates. Matching distance values showed Texas isolates 1, 2, 7, and 8 to all be the same, but significantly different from the typical *F. O.* f. sp. *betae* isolates with MD of 11.9. The two typical *F. O.* f. sp. *betae* isolates, 5 and 6, were closely related.

From an academic stand point, these results suggest that the Texas isolates should possibly be given a new taxonomic designation other than *F. O.* f. sp. *betae*. The practical implications are that a cultivars breed for resistance to the typical *F. O.* f. sp. *betae* may be susceptible to the Texas isolate.

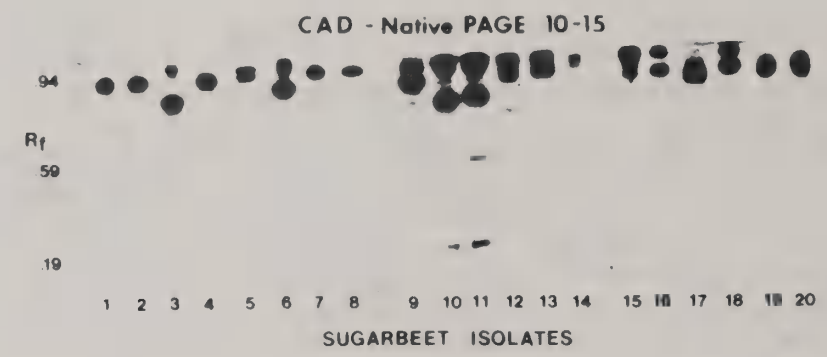
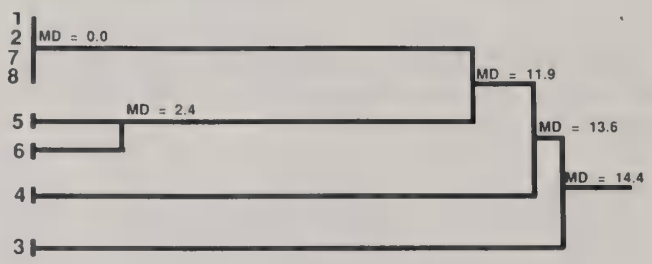


FIG. 1. Native PAGE (10-15% gradient) gels of cinnamyl alcohol dehydrogenase (CAD) isozymes from 20 isolates of *Fusarium*. Isolates 12 and 13 are *F. graminearum* and isolate 14 is *F. solani*. All others are *F. oxysporum* obtained from sugar beets. R_f = distance isozyme has moved from the origin relative to distance buffer front has moved.



ISOLATE #	DESCRIPTION
1	*F. oxysporum* (TX) F5 Plant Root
2	*F. oxysporum* (TX) F4 Plant Root
3	*F. graminearum* (PSU)
4	*F. solani* (TX)
5	*F. o. betae* (CA) 1281-2 (86)
6	*F. o. betae* (OR) ATCC 34296
7	*F. oxysporum* (TX) F4 Stock
8	*F. oxysporum* (TX) F5 Stock

FIG. 2. Phenogram of sugar beet isolates of *F. oxysporum* constructed from matching distances generated by a binomial hierarchical cluster analysis of isozyme patterns for cinnamyl alcohol dehydrogenase, esterase, and glucose-6-phosphate dehydrogenase. Matching distances of 0.0 indicate no difference among isolates.

SUGAR BEET SEED PRIMING
(BSDF Project 130)

C. M. Rush

Seed priming is a treatment in which the germination process is initiated but stopped before radicle emergence. Primed seed emerge faster and more uniformly than non-primed seed, and priming has also been reported to reduce incidence of Pythium damping off. Historically, priming has been achieved using osmotic solutions such as salts and polyethylene glycol. Simply soaking seed in pure water is also a type of priming, but generally not as effective or controllable as other methods. Recently a new technique of seed priming called solid matrix (SMP) has been developed.

Solid matrix priming is a method in which seed are mixed with a clay mineral substrate or some other solid material and water is added to the system. The seed, substrate, water mix is incubated over several days, and then the dried substrate is screened off. This method is fundamentally different from osmopriming in that matric water potential is controlled as opposed to osmotic potential.

In last years research, SMP was compared to osmopriming with NaCl and PEG, and also to washing only, with regard to emergence, rate of emergence (MER), susceptibility to *Pythium ultimum* and *Aphanomyces cochliodes*, and final stand. Five cultivars were used in these studies to determine the applicability of SMP to different cultivars. There were six replications of each cultivar, seed treatment, pathogen combination.

The effects of different seed treatments, on early emergence and final stand in different soils, and on MER can be seed in Table 1. Seed treatment effects on early emergence, MER, and final stand with each cultivar can be seen in Tables 2, 3, and 4, respectively.

In general, all priming treatments resulted in higher early seedling emergence values and lower MER than seed washed only or non-treated (Table 1). However, SMP was typically superior to all other treatments. Neither SMP or any other seed treatment affected post emergence damping off due to Aphanomyces. However, SMP gave significantly higher final stands in Pythium infested soils. Seed which was washed only had the highest final emergence in non-infested soils, but did very poorly in Pythium infested soil. All cultivars tested showed improved performance after seed priming regardless of method.

TABLE 1. Effects of seed treatment on early seedling emergence, mean rate of emergence (MER), and final stand[x].

Seed Treatment	Aphanomyces[y] 3 days	Aphanomyces[y] 15 days	Pythium 3 days	Pythium 15 days	Control 3 days	Control 15 days	MER[z]
SMP	58.2 a	22.3 a	37.2 a	41.3 a	56.3 a	83.4 b	2.34 a
NaCl	23.9 b	19.6 a	14.0 b	35.2 b	22.4 b	80.6 bc	2.94 b
PEG	14.1 c	21.6 a	11.3 b	32.6 b	12.3 c	77.6 c	3.10 bc
Washed	8.3 c	22.6 a	2.2 c	13.6 c	10.1 c	89.4 a	3.23 c
Control	1.4 d	24.3 a	0.7 c	16.3 c	2.2 d	79.0 bc	3.96 d

[x] Values represent means from 6 replications of each seed treatment - pathogen combination inclusive of all five cultivars.

[y] Means in each column followed by the same letter are not significantly different according to Duncan's test (P=0.05).

[z] MER = MER = (N) + T2 N2 + . . . + Tn Nn/total number of sedlings emerged, where N = number of seedlings emerged each day and T = day number. Values for seedlings in noninfested soils.

Values for seedings in noninfested soil only.

TABLE 2. Early seedling emergence as affected by cultivar and seed treatment[x].

Cultivar	SMP[y]	NaCl	PEG	Washed	Control
			(% Emergence)		
Ach 146	54.2 ab A	26.5 a B	15.9 b C	9.0 ab CD	3.0 a D
Ach 177	61.5 a A	28.5 a B	24.6 a B	12.9 a C	0.6 b D
HH 42	45.7 b A	23.7 a B	13.5 b C	3.5 c D	1.3 ab D
Tx-9	47.0 b A	11.1 b B	3.7 c BC	7.0 bc CD	1.1 ab D
Tx-18	44.4 b A	10.7 b B	5.2 c C	2.8 c C	1.3 ab C

[x] Values represent mean emergence of each cultivar seed treatment combination inclusive of three soil treatments; control, Pythium infested, and Aphanomyces infested.

[y] Values in each column followed by the same small letter are not significantly different (P=0.05) according to Duncan's Test. Values in each row followed by the same capital letter are not significantly different (P=0.05).

TABLE 3. Final stand as affected by cultivars and seed treatment[x].

Cultivar	SMP	NaCl	PEG	Washed	Control
		(% of seed planted)			
Ach 146	54.1 a A	51.8 a AB	48.1 a AB	43.7 a B	44.2 a B
Ach 177	53.9 a A	50.4 ab AB	48.5 a AB	42.2 a AB	44.8 a B
HH 42	51.8 a A	40.0 c B	44.4 ab AB	43.5 a AB	39.8 ab B
Tx-9	39.2 b A	40.0 c A	37.9 b A	40.2 a A	32.6 b A
Tx-18	46.1 ab A	43.3 bc A	40.4 ab A	39.8 ab A	38.0 ab A

[x] Values represent mean emergence of each cultivar seed treatment combination inclusive of three soil treatments\; control, Pythium infested, and Aphanomyces infested.

[y] Values in each column followed by the same small letter are not significantly different (P=0.05) according to Duncan's Test. Values in each row followed by the same capital letter are not significantly different (P=0.05).

TABLE 4. Mean rate of emergence (MER) as affected by cultivar and seed treatment[xy].

Cultivar	SMP	NaCl	PEG	Washed	Control
Ach 146	2.3 a A	2.7 a B	3.0 a BC	3.1 ab C	3.9 a D
Ach 177	2.4 a A	2.7 a B	2.8 a BC	3.0 a C	3.7 a D
HH 42	2.3 a A	3.0 a B	2.9 a B	3.2 ab B	4.0 ab C
Tx-9	2.5 a A	3.2 a B	3.3 a B	3.3 ab B	3.8 a C
Tx-18	2.2 a A	3.1 a B	3.3 a B	3.4 b B	4.4 b C

[x] Values represent mean emergence of each cultivar seed treatment combination inclusive of three soil treatments; control, Pythium infested, and Aphanomyces infested.

[y] MER = (N) + T2 N2 + . . . + Tn Nn/total number of sedlings emerged, where N = number of seedlings emerged each day and T = day number. Values for seedlings in noninfested soils.

BIOLOGICAL CONTROL AND PATHOGENIC VARIATION OF *APHANOMYCES COCHLIOIDES*
(BSDF Project 990)

C. M. Rush and Y. Yeh

Biological Control. A greenhouse study was conducted to evaluate potential biocontrol agents for activity against *Aphanomyces cochlioides*. An isolate of *Gliocladium virens*, GL-21, obtained from George Papavizas was used. Nonsterile soil was infested *A. cochlioides* and then GL-21 treated and nontreated sugar beet seed were planted. An Aphanomyces resistant breeding line 85303-0 obtained from Claire Theurer and Tachigaren treated seed were used as resistant controls.

Aphanomyces seedling disease began to appear approximately 14 days after planting. Disease progressed rapidly, and the GL-21 treated seedlings showed no reduction in susceptibility as compared to the non treated control. The resistant variety held up well and had fewer infected plants and less severe symptoms on infected plants. Seed treated with Tachigaren had very little disease for approximately three weeks but then seedlings died rapidly. The extremely high incidence of disease led us to conclude that conditions had been too favorable for disease development and the study was repeated. However, in the second test seedlings began to die very early and Rhizoctonia was isolated from diseased seedling. The test was scrubbed and the soil was fumigated. We are presently reestablishing Aphanomyces as the only pathogen in our test soils.

Intraspecific Variation. As part of her graduate dissertation. Ms. Ying Yeh evaluated eight isolates of *Aphanomyces cochlioides* for genetic variation using RFLP analysis of isolated mitochondrial DNA. Seven isolates were from the United States and one from Sweden. Isolates were digested using EcoR I, Hind III, Bam HI and Pst I restriction enzymes. No variation in restriction digestion patterns was observed when the latter two enzymes were used, but variation was observed using EcoRI and Hind III. All American isolates were practically identical, but they could be differentiated from the Swedish isolate. These results are encouraging because they indicate that Aphanomyces resistant breeding lines or cultivars can be used anywhere in the United States with expectations of similar performance among sites.

SUGARBEET RESEARCH

1989 Report

Section H

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The research was supported in part by funds provided through the Cornell University and the Beet Sugar Development Foundation (Project 230).

CONTENTS

KHAN, A. A., H. MIURA, J. PRUSINSKI and S. ILYAS. Matriconditioning of seeds to improve performance. Proc. National Symp. Stand Establishment Hort. Crops, April 4-6, Minneapolis, MN (in press).

Various preplant physiological seed conditioning procedures have been used to improve seed performance. Among these are: presoaking, wetting and drying, humidifying, pregermination and priming or osmoconditioning. More recently, solid and semi-solid support systems have been used to condition seeds. A high negative water potential (=osmotic potential + matric potential) of the conditioning medium can be used to regulate the amount of water absorbed by the seed and to achieve a moisture equilibrium needed for seed conditioning. We have developed a procedure, termed 'matriconditioning' using chemically inert, highly porous, water insoluble, inorganic carriers, with high water holding capacity. The procedure differs from osmoconditioning or solid matix priming in several ways. The materials found particularly suitable for matriconditioning are the various grades of synthetic calcium silicates (e.g. Micro-Cel E™) and the finer grades of Zonolite™ Vermiculite (e.g., grade #5). These materials generate no osmotic potential; however, the high porosity and the high water holding capacity (upto 650% of their own weight in water) of these substances allow them to develop a high negative matric potential required for matriconditioning of seeds .

Large (bean, soybean) and small (pepper, tomato, onion, carrot, celery, beet, sugarbeet, lettuce) vegetable and flower (*Impatiens* , *Primula*) seeds have been successfully matriconditioned. Depending upon the seeds used, varying degrees of improvement in the storability, the time to germination, the rate of emergence, stand size, cold hardiness, and the prevention of thermoinhibition have been achieved. The treatment is generally superior to osmoconditioning in PEG solution. Because of the diverse particle size and structure and the large surface area, the carriers used for matriconditioning offer an ideal system for immobilizing enzymes and catalysts; incorporating hormones, nutrients and pesticides; and for multiplying beneficial microbes in and around the seed and delivering them to the target areas in the rhizosphere to combat destructive pests and diseases.

CONDITIONING OF SUGARBEET SEEDS TO IMPROVE STAND ESTABLKISHMENT

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Origin of the matriconditioning concept

Previous studies with beet seeds indicated that when a period of relative dryness of the field soil after planting was followed by a wet period there was a resurgence of seedling emergence (Khan et al. Agron. J. 75: 788, 1983). This indicated that the dry soil might create a low water potential microenvironment favoring partial hydration and invigoration of seeds in a manner similar to that achieved by osmotically active substances during preplant priming or osmoconditioning. However, as the water potential (=osmotic potential + matric potential) of most soils is predominantly a function of the matric properties of the solid phase, we explored the possibility of developing a preplant seed conditioning treatment which would utilize the matric potential component of the solid substances. The substances which proved highly suitable for this purpse were various grades of vermiculite and natural diatomite and synthetic silicates. Unlike osmoconditioning or priming (liquid or solid), which employs the osmotic properties of the solute(s) to condition seeds, matriconditioning is dependent upon the matric properties of the material. Hence, the term matriconditioning has been coined to distinguish it from osmoconditioning (or priming).

Characteristics of solid substances needed for matriconditioning

The substances for matriconditioning should ideally have the following characteristics:

1) High matric potential and negligible solute or osmotic potential
2) Negligible water solubility
3) Chemically inert
4) High water holding capacity
5) High flowability, capacity to remain dry, free-flowing powder
6) Variable particle size, structure and porosity
7) High surface area
8) High bulk value and low bulk density, providing results at very low levels of addition
9) Ability to adhere to seed surface

The substances which possessed these characteristics were various grades of vermiculte (e.g. , Zonolite Vermiculite grades #4 and #5) and natural diatomite (e.g., Celite 400) and synthetic silicates (e.g., Micro-Cel E).

Development of the procedure for matriconditioning

The following steps were needed to matricondition seeds:

1) The sugarbeet ('E-4', size medium, untreated) seeds used in this study were obtained from Hilleshog Mono-Hy Inc., Longmont, Colorado.

2) Matriconditioning was conducted in loosely capped jars by mixing seeds with various carriers and water. The optimal or near optimal proportion of seed: carrier : water by weight for selected carriers were as follows: a)1 part seed: 0.2 part Micro-Cel: 0.8 part water ,b) 1 part seed: 0.25 part vermiculite: 0.63 part water and c) 1 part seed: 0.5 part Celite 400: 1 part water. Prior to its use, Zonolite vermiculite was ground in a coffee grinder to a fine powder (90% <50 mesh).

3) Micro-Cel and Zonolite vermiculite had negligible solute or osmotic potential.The matric potential of these carriers required to prevent germination during conditioning varied from -7.5 to -12 bars . In comparison, the organic carrier, Agro-Lig, used in solid matrix priming (Taylor et al . Scientia Hort. 37: 1, 1988) was found to generate a large osmotic potential (-9.4 bar) and a negligible matric potential.

4) The optimum period for matriconditioning was found to be 7 days.

5) The temperature during matriconditioning was maintained at about 15^0C.

6) Micro-Cel, vermiculites and celites could either be removed from seeds after matriconditioning by rinsing in water or left adhering to seeds at the time of sowing.

Improvements in seedling emergence

Some of the highlights of matriconditioning research with sugarbeet seeds are presented here. Matriconditioning in Micro-Cel E , Celites and Zonolite vermiculite reduced the germination time, increased the rate of emergence and improved the stand size compared to untreated seeds. The treatment was generally superior to priming seeds in -12 bar polyethylene glycol 8000 (PEG) solution or priming in Agro-Lig, the carrier used in solid

matrix priming. The total emergence and the time to 50% of final emergence (T50) in several matriconditioned, primed and untreated vegetable seeds sown in Cornell Peat-Lite Mix at 12h, 20^0C day/10^0C night temperature regime are described.

1) *Comparison of matriconditioning with osmoconditioning in PEG-8000 and solid matrix priming in Agro-Lig:*

Following preplant solid and liquid seed conditioning systems were used: a) 1 parrt seed to 0.2 part Micro-Cel to l part water (0.2% Thiram), b) 1 part seed to 0.5 part Celite 400 to 1 part water (0.2% Thiram), c) 1 part seed to 1.5 part Agro-Lig to 0.53 part water (0.2% Thiram), and d) -12 bar PEG 8000 solution amended with 0.2% Thiram. Following conditioning, seeds were rinsed with water before planting.

Treatment	Total emergence (%)	T50 (day)
Untreated	88b	4.9a
Matriconditioned (Micro-Cel E)	95a	2.3c
Matriconditioned (Celite 400)	97a	2.3c
Primed (PEG)	93a	3.6b
Primed (Agro-Lig)	95a	3.5b

Mean values followed by different lower case letters in columns are significant at 5% level.

2) *Effect of matriconditioning using Zonolite vermiculite as a carrier:*

Matriconditioning systems consisted of 1 part seed (S) to 0.24-0.25 part vermiculite (V) to 0.38-0.625 part water (0.2% Thiram.) (W). Following matriconditioning, seeds were washed prior to planting.

Treatment	Total emergence (%)	T50(day)	Fr wt/15 shoot,g
Untreated	90a	4.9a	0.99d
Matriconditioned:			
1 part S: 0.25 part V: 0.625 part W	97a	2.4d	2.04a
1 part S: 0.24 part V: 0.60 part W	93a	2.4d	2.03a
1 part S: 0.25 part V: 0.55 part W	91a	2.7c	1.58b
1 part S: 0.25 part V: 0.50 part W	96a	2.8bc	1.63b
1 part S: 0.25 part V: 0.40 part W	97a	3.0b	1.27c
1 part S: 0.25 part V: 0.38 part W	95a	3.5b	1.30c

3) *Comparison of Micro-Cel E and Zonolite vermiculite as carriers for matriconditioning of sugarbeet seeds:*

Following preplant solid and liquid seed conditioning systems were used: a) 1 part seed to 0.2 part Micro-Cel E to 0.8 part water (0.2% Thiram), b) 1 part seed to 0.25 part Zonolite vermiculite to 0.625 part water (0.2% Thiram), c) -12 bar PEG 8000 solution amended with 0.2% Thiram. Following conditioning, seeds were rinsed with water before planting.

Treatment	Total emergence (%)	T50(day)	Fr wt/15 shoots,g
Untreated	85b	5.2a	1.12c
Matriconditioned (Micro-Cel E)	90a	2.4c	2.20a
Matriconditioned (vermiculite)	96a	2.5c	2.04a
Osmoconditioned (PEG 8000)	90a	4.1b	1.52b

4) *Effect of washing / no washing of carriers following matriconditioning on seed performance:*

Following preplant matriconditioning systems were used: a) 1 part seed to 0.2 part Micro-Cel E to 1 part water (0.2% Thiram), b) 1 part seed to 0.4 part Celite 400 to 1 part water

(0.2% Thiram). Following conditioning, seeds were either washed to remove the carriers or were left unwashed prior to planting.

Treatment	Total emergence (%)	T50 (day)
Untreated	89b	4.8b
Matriconditioned (Micro-Cel E) Washed	95a	2.5a
Matriconditioned (Micro-Cel E) Unwashed	94a	2.4a
Matriconditioned (Celite 400) Washed	93a	2.4a
Matriconditioned (Celite 400) Unwashed	94a	2.5a

5) *Other significant observations:*

a) It was found that Celites # 209 and #379 could also be used as carriers for matriconditioning of sugar beet seeds; however, because of their low water holding capacity, relatively large amounts were needed to generate a high matric potential needed for matriconditioning.

b) Following matriconditioning in Micro-Cel E or Zonolite vermiculite, sugarbeet seeds were stored at 7^0C, 28% RH for two months (longer storage under these conditions are possible) without a loss in the advantages gained by matriconditioning.

c) Because of the high porosity of carriers, such as Micro-Cel E and Zonolite vermiculite, large batches of seeds could be matriconditioned with a minimum of seed movement or aeration

d) Inhibitors present in sugarbeet seeds appear to be readily adsorbed by Zonolite vermiculite or Micro-Cel E, obviating the need for extensive washing before or after matriconditioning.

Advantages of matriconditioning and differences from priming or osmoconditioning

1) Matriconditioning depends upon the matric properties of the conditioning medium of the carrier substance instead of the solute properties of the medium used in liquid or solid priming or osmoconditioning. In priming or osmoconditioning, seed conditioning is achieved by the osmotic forces of the dissolved substances in the carrier. In contrast, matriconditioning is achieved by the water retentive physical forces of the carrier matrix. This is consistent with the relatively low water holding capacity and the high osmotic effect of carriers used in solid matrix priming, such as Agro-Lig (which holds only 30-40% of its own weight in water), and the negligible osmotic effect and the high water holding capacity of carriers, such as natural diatomite or synthetic silicates (e.g., Micro-Cel, which holds 550 to 650% of its own weight in water) or various grades of Zonolite vermiculite (which holds upto 450% of its own weight in water), used in matriconditioning.

2) Materials found successful for matriconditioning, such as various grades of Micro-Cel and Celite or Zonolite vermiculite are chemically inert, water insoluble inorganic substances unlike materials used for liquid or solid priming or osmoconditioning, such as soluble salts and polyethylene glycol or organic materials rich in soluble substances.

3) Micro-Cel E and Zonolite vermiculite have characteristics which make them highly efficient carriers for immobilizing enzymes and catalysts, for incorporating nutrients, pesticides and hormones and for use as delivery systems for beneficial microbes (bacteria and fungi) against destructive soilborne insects and diseases during seedling establishment. Thus, seed invigoration by matriconditioning may be combined with the protective, nutritive and stress allevating factors during stand establishment.

4) Because of the high bulk value of the carriers (e.g.,bulk densities of Micro-Cel E and Zonolite vermiculite are 5.5 and 7.0 lbs/cu.ft., respectively) used for matriconditioning, the procedure requires a much smaller amount of carrier than is needed with liquid or solid priming (bulk density of Agro-Lig is 40lbs/cu.ft.). Thus, matriconditioning may be more cost effective than priming.

5) The high water to carrier ratio and the large surface area of Micro-Cel E and Zonolite vermiculite during matriconditioning appears to allow ready exchange and diffusion of

toxic substances and inhibitors known to be present in sugarbeet seeds, thus diluting the inhibitor content of the seed and consequently improve seedling establishment.

6) The uncharacterized soluble substances present in organic carriers (e.g, Agro-Lig) in relatively large quantities may interfere with seeds, bioactive chemicals or the biocontrol agents in an unpredicted manner. The use of chemically inert, water insoluble inorganic carriers, such as Micro-Cel and Zonolite vermiculite, may allow the added bioactive chemicals and biocontrol agents to act in a highly predictable fashion.

7) There is no need to remove the carriers adhering to the seed surface following matriconditioning. The carrier particles surrounding the seed easily blend into the soil, which has similar matric properties as these substances. Upon planting, the excess amount of water present in the soil seemingly reduces the matric forces of the carrier, restoriong the water uptake capacity of the seed needed for germination.